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PRELIMINARY LIST OF NEW YORK UNIONIDÆ

BY

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ASSISTANT ZOOLOGIST

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1892

M. 24. M. 92-1500.

Regents

PRELIMINARY LIST OF NEW YORK UNIONIDÆ

INTRODUCTION

Unless otherwise stated all the species in the following list are represented in the collection of the New York State Museum by specimens from localities within the limits of the state of New York or from the Alleghany river at Warren, Penna., just south of the New York boundary. A name printed in *italics* indicates that the species has been included without positive evidence that it inhabits New York.

This list has been prepared for distribution among conchologists with a view to obtaining data bearing upon the geographical distribution of the Unionidæ inhabiting the state of New York. For this reason the names of the species have been arranged alphabetically and a space for notes has been left under the name of each species.

Recipients are requested to furnish the undersigned with all information in their possession regarding:

1 The general distribution of each species.

2 The distribution of each species in the state of New York.

3 The causes which tend to restrict or extend the habitat of each species in the state of New York.

4 The reasons why there are numerous species in the waters of the western part of the state and few species in the waters of the eastern part.

The general distribution of each species can be given by a list of all localities in which the species is known to occur; or by a list of selected localities which will serve to show the streams inhabited by the species and the extreme points at which it has been found.

The distribution of each species in the state of New York can be best shown by a list of all localities in which the species is known to occur.

All information placed at the disposal of the undersigned will be thankfully received and duly acknowledged in a subsequent list.

Contributions of specimens with well-preserved beaks are respectfully solicited for the collection of the New York State Museum.

WILLIAM B. MARSHALL

New York State Museum
Albany, N. Y.,
February 12, 1892.

NEW YORK UNIONIDÆ

1 alatus (Unio), Say.

2 *anodontoides (Unio), Lea.*

3 Benedictii (Anodonta), Lea.

4 **Boydianus (Unio), Lea.**

5 **cariosus (Unio), Say.**

6 **clavus (Unio), Lamarck.**

7 ***coccineus (Unio), Lea.***

8 ***complanata (Margaritana), Barnes.***

9 complanatus (Unio), Solander.

10 crassidens (Unio), Lamarck.

11 *deltoidea (Margaritana), Lea.*

12 edentula (Anodonta), Say.

13 *elegans (Unio), Lea.*

14 *ellipsis (Unio), Lea.*

15 fabalis (Unio), Lea.

16 *Ferussaciana (Anodonta), Lea.

17 fluviatilis (Anodonta), Dillwyn.

18 Footiana (Anodonta), Lea.

* Erie canal — De Kay.

19 fragilis (Anodonta), Lamarck.

20 gibbosus (Unio), Barnes.

21 gigantea (Anodonta), Lea.

22 gracilis (Unio), Barnes.

23 heterodon (Unio), Lea.

24 ***Hildrethiana (Margaritana), Lea.***

25 ***hippopæus (Unio), Lea.**

26 **imbecillis (Anodonta), Say.**

27 **implicata (Anodonta), Say.**

28 **iris (Unio), Lea.**

* Lake Erie — Lea. Typical locality.

29 lacustris (Anodonta), Lea.

30 lævissimus (Unio), Lea.

31 Lewisii (Anodonta), Lea.

32 ligamentinus (Unio), Lamarck.

33 luteolus (Unio), Lamarck.

34 margaritifera (Margaritana), Linnæus.

35 marginata (Margaritana), Say.

36 multiradiatus (Unio), Lea.

37 nasutus (Unio), Say.

38 Novi-Eboraci (Unio), Lea.

39 occidens (Unio), Lea.

40 ochraceus (Unio), Say.

41 ovatus (Unio), Say.

42 parvus (Unio), Barnes.

43 patulus (Unio), Lea.

44 *pavonia (Anodonta), Lea.

45 perplexus (Unio), Lea.

46 phaseolus (Unio), Hildreth.

47 *plana (Anodonta), Lea.

48 pressus (Unio), Lea.

* Onondaga Lake — De Kay.

49 *pustulatus* (*Unio*), *Lea.*

50 radiatus (Unio), Lamarck.

51 rectus (Unio), Lamarck.

52 rubiginosus (Unio), Lea.

53 rugosa (Margaritana), Barnes.

54 ***spatulatus* (*Unio*), *Lea*.**

55 **subcylindracea (Anodonta), Lea.**

56 **Tappanianus (Unio), Lea.**

57 ***triangularis (Unio), Barnes.**

58 ***trigonus* (*Unio*), *Lea*.**

* Niagara River — Lea.

59 undulata (Anodonta), Say.

60 undulata (Margaritana), Say.

61 undulatus (Unio), Barnes.

62 ventricosus (Unio), Barnes.

63 verrucosus (Unio), Barnes.

BULLETIN

OF THE

NEW YORK STATE MUSEU[M]

OF

NATURAL HISTOR[Y]

VOL. I.—NO. 2

May 1887

CONTRIBUTIONS TO THE BOTANY OF THE STATE OF N[EW] YORK BY CHARLES H. PECK STATE BOTANIST

PRINTED FOR THE MUSEUM

ALBANY
CHARLES VAN BENTHUYSEN & SONS
1887

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CONTENTS.

* The titles of the first four articles were enumerated in the Thirty-seventh Report on the State Museum, but the articles were not printed. A revision of them is here given.

NEW SPECIES OF NEW YORK FUNGI.

Tricholoma infantilis.

Pileus thin, convex or nearly plane, even, minutely silky, moist in wet weather, reddish-gray, the margin when young incurved and whitish; lamellæ subdistant, plane or slightly ventricose, often eroded on the edge, whitish; stem short, equal or tapering upward, hollow, slightly silky, colored like the pileus or a little paler; spores broadly elliptical, .0003 to .00035 in. long, .0002 to .00025 broad, often containing a shining nucleus.

Plant gregarious, pileus 4 to 12 lines broad, stem 1 to 1.5 in. high, 1 to 2 lines thick.

Gravelly soil in fields. Sandlake. June.

This is a very small species belonging to the section SERICELLA and related to *Tricholoma cœlata*, from which it is distinguished by its different color and the absence of an umbilicus from the pileus. This is sometimes papillate, and both it and the stem imbibe moisture. The latter is fleshy-fibrous, and its cavity is very small. In the larger specimens the margin of the pileus is often wavy, and the edge of the lamellæ eroded. *Tricholoma Hebeloma*, a closely allied species, may be distinguished by its more conical pileus, slender habit and smaller spores.

Clitocybe basidiosa.

Pileus rather thin, convex, then expanded and umbilicate or centrally depressed, glabrous, hygrophanous, grayish-brown and striatulate on the margin when moist, dingy-white or grayish-white when dry, flesh whitish; lamellæ arcuate or nearly plane, thick, distant, adnate or slightly decurrent, whitish with a violaceous tint; stem equal or slightly thickened above, glabrous, firm, whitish or pallid; spores subglobose, .00016 to .0002 in. long, basidia elongated, .0024 in. long, bearing spicules .0003 in. long.

Plant single or cæspitose, 1 to 2 in. high, pileus 16 to 18 lines broad, stem 1 to 2 lines thick.

Woods and swamps. Sandlake and East Berne. August.

The numerous narrow and elongated basidia of this species are suggestive of the specific name. The plant is also easily recognized by the peculiar, pale, livid gray hue of the pileus, and the slight violaceous tint of the lamellæ. The pileus is rarely slightly umbonate. When dry both it and the stem have a slight silky appearance. The stem is usually solid, and slightly enlarged as it enters the pileus. The species should be placed among the ORBIFORMES, though in some respects it approaches *C. obbatus* and *C. Calathus*. It also has the aspect of some species of Hygrophorus.

Collybia alcalinolens.

Pileus thin, subconical or convex, then expanded, slightly silky-fibrillose, shining, hygrophanous, dark watery-brown when moist, grayish-brown or cinereous when dry, flesh white; lamellæ rather broad, subdistant, adnate or emarginate with a decurrent tooth, whitish; stem equal, glabrous, slightly pruinose above, hollow, shining, whitish; spores broadly elliptical, .0003 to .00035 in. long, .0002 to .00025 in. broad.

Plant gregarious, 1 to 2 in. high, pileus 8 to 18 lines broad, stem 1 to 3 lines thick.

Thin woods and bushy places. Sandlake. June and July.

This species has a peculiar odor resembling that of chloride of lime. In this respect it is similar to some species of Mycena. The plant is quite variable. The disk of the pileus is now elevated, now depressed, sometimes darker than the rest, sometimes canescent with short, grayish fibrils. The margin is quite thin and sometimes striatulate when moist. Occasionally it surpasses the lamellæ, which in the expanded plant are often ventricose. The stem is sometimes irregular or compressed. The species belongs to the section TEPHROPHANÆ, and is apparently allied to *A. laceratus*.

Leptonia albinella.

Pileus submembranous, subconical or convex, subumbilicate, furfuraceous or minutely squamulose, hygrophanous, whitish and striatulate on the margin when moist, white and shining when dry; lamellæ narrow, close, adnexed, white, becoming incarnate; stem equal, hollow, glabrous or slightly pruinose, whitish; spores angular, .00045 to .0005 in. long, .0003 to .00035 in. broad.

Plant 1.5 to 2 in. high, pileus 6 to 12 lines broad, stem 1 line thick.

Bushy places. Sandlake. July.

Readily distinguished from its allies by its white color. *Leptonia assularum* B. & C. differs in having an umbonate virgate pileus with a dark center. *Nolanea delicatulus* is a more slender, delicate plant with a smoother pileus and not at all umbilicate.

Psilocybe castanella.

Pileus thin, at first convex or subconical, then expanded or slightly depressed, glabrous, hygrophanous, chestnut-colored or umber-brown and striatulate on the margin when moist, pale-alutaceous when dry, flesh a little paler than the surface of the pileus; lamellæ close, adnate or slightly rounded behind, at first pale-brown, then purplish-brown; stem equal, flexuous, hollow or stuffed with a whitish pith, slightly silky-fibrillose, brownish or subrufescent with a white mycelium at the base; spores purplish-brown, .0003 to .00032 in. long, .00016 to .0002 in. broad.

Plant gregarious or subcæspitose, 1 to 2 in. high, pileus 4 to 8 lines broad, stem .5 to 1 line thick.

Rich grassy ground by roadsides. Sandlake. June.

The species appears to be closely allied to *Agaricus squalens*, which may be distinguished by its lurid color, decurrent lamellæ and ferruginous-brown spores. Moreover its habitat is unlike that of our plant. In very wet weather both the pileus and lamellæ sometimes have a watery-brown appearance, and then the striations of the former sometimes extend to the disk, which is rarely slightly umbonate. In drying, the moisture first disappears from the center of the pileus. The young pileus is usually chestnut-colored, and its margin and the stem are adorned with a few whitish fibrils.

Psilocybe fuscofulva.

Pileus thin, convex or subcampanulate, subumbonate, glabrous, hygrophanous, dark watery-brown and striatulate on the margin when moist, subochraceous when dry; lamellæ rather broad, moderately close, adnate, subventricose, purplish-brown; stem slender, flexuous, stuffed, slightly silky, reddish-brown; spores purplish-brown, .0004 to .0005 in. long, .00025 to .0003 in. broad.

Plant 1.5 to 2.5 in. high, pileus 6 to 12 lines broad, stem 1 to 2 lines thick.

Among sphagnum. Karner. October.

The species is related to *Agaricus atrobrunneus*, but its smaller size and differently colored lamellæ will serve to distinguish it.

Dermocybe simulans.

Pileus fleshy, thin, convex, then expanded, at first grayish-violaceous and silky-fibrillose, then pale-cinereous, often tinged with yellow or brownish-yellow on the disk, flesh pale-violaceous or pale-cinereous; lamellæ rather broad, subventricose, rounded behind, moderately close, violaceous, becoming cinnamon-colored; stem short, equal or slightly thickened at the base, silky-fibrillose, shining, stuffed or hollow, violaceous, becoming whitish or pallid; spores subglobose or broadly elliptical, .0003 to .00035 in. long, .00025 to .0003 in. broad.

Plant 1 to 2 in. high, pileus 6 to 18 lines broad, stem about 2 lines thick.

Woods. Sandlake. July.

The colors of this species are so similar to those of *Inoloma albo-violacea* that the plant might at first sight be mistaken for a small form of that species, but its small size, thin pileus and short, hollow stem afford distinguishing characters.

Telamonia gracilis.

Pileus thin, convex or campanulate, then expanded, umbonate, floccose-fibrillose, hygrophanous, watery-brown or sordid-chestnut when moist, whitened on the margin with grayish fibrils, subochraceous or tawny-cinnamon when dry; lamellæ thin, subdistant, becoming subventricose, ferruginous-brown, becoming cinnamon-colored; stem long, slender, flexuous, fibrillose and slightly floccose-scaly, with a slight whitish evanescent annulus, colored like the pileus; spores elliptical, uninucleate, .0004 to .00045 in. long, .00025 to .0003 in. broad.

Plant 2 to 4 in. high, pileus 6 to 12 lines broad, stem 1 to 2 lines thick.

Among moss and sphagnum in marshes. Sandlake. August.

The umbo is small and sometimes acute, rarely obsolete. The dry pileus varies much in color, it being tawny, cinnamon, subochraceous or grayish-cervine. The young lamellæ also vary from ferruginous-brown to reddish-umber and sometimes have a slight violaceous tint. The species is apparently related to *Telamonia flexipes* and *T. rigida*, but the first is described as having the stem violaceous at the apex, and the second as having the pileus glabrous, both of which characters are wanting in our plant.

Variety *brevipes* has the stem but 1 or 2 inches long. It occurs on decaying wood.

Hydrocybe præpallens.

Pileus fleshy, thin, subconical, then convex or expanded, glabrous, hygrophanous, watery-brown or chestnut-colored when moist, pale-ochraceous when dry, flesh yellowish-white; lamellæ close, lanceolate, rounded behind or slightly emarginate, reddish-umber, becoming tawny-cinnamon; stem short, equal, subflexuous, fleshy-fibrous, slightly silky, pallid or brownish; spores subelliptical, .0003 to .0004 in. long, .00025 in. broad.

Plant 1 to 3 in. high, pileus 6 to 18 lines broad, stem 2 to 4 lines thick.

Naked soil in woods. Sandlake. June.

The difference in the color of the moist pileus and the dry one is quite decided. The change from the dark-chestnut color of the one to the dingy-yellow or isabelline hue of the other is very noticeable and suggestive of the specific name. The fibrils of the veil are grayish-white, and the margin, which is at first incurved, is apt to become wavy, irregular or reflexed in large specimens. In the thinner specimens it is striatulate when moist. The lamellæ are narrowed toward the outer extremity and when young are of a peculiar reddish-brown or dark-ferruginous hue. The stem is usually hollow, but apparently from the erosion of insects. The species belongs to the section FIRMIORES.

Hygrophorus minutulus.

Pileus thin, submembranous, convex or expanded, subumbilicate, bright-red, viscid and distantly striatulate when moist, pale-red or yellowish when dry; lamellæ rather broad, subdistant, sometimes ventricose, adnate or subsinuate and slightly decurrent, whitish, tinged with red or yellow; stem short, slender, fragile, solid, viscid when moist, yellowish; spores narrowly elliptical, .0004 in. long, .0002 in. broad, borne on slender spicules which are .0002 to .0003 in. long.

Plant 6 to 10 lines high, pileus 3 to 5 lines broad, stem scarcely half a line thick.

Grassy ground in pastures. Sandlake. July.

This is one of our smallest species of Hygrophorus. Its nearest relative is *H. aurantiacoluteus* B. & C., from which the viscid pileus and stem and less decurrent lamellæ separate it. As the moisture escapes from the fresh plant the pileus becomes paler and assumes a slight silky appearance, but often the thoroughly dried specimens

resume the bright-red hue of the fresh plant. Often several basidia grow from the same filament.

Russula albida.

Pileus thin, broadly convex, then expanded or depressed, glabrous, viscid when moist, white, sometimes slightly tinged with yellow, the spreading or erect margin at length slightly and narrowly tuberculose-striate, flesh white; lamellæ adnate or subdecurrent, moderately close, some of them forked near the stem, white, the interspaces venose; stem nearly equal, glabrous, stuffed or hollow, white; spores white, minutely rough, subglobose or broadly elliptical, .00035 in. long, .0003 in. broad; taste mild or bitterish.

Plant 1 to 3 in. high, pileus 1 to 2.5 in. broad, stem 3 to 6 lines thick.

Woods. Sandlake. July and August.

This Russula belongs to the section FRAGILES. It may be distinguished from white forms of *Russula emetica* by its adnate or slightly decurrent lamellæ and by its milder taste.

Russula uncialis.

Pileus thin, convex, then expanded or centrally depressed, viscid when moist, glabrous or very minutely rivulose-granulose, red or pinkish-red, the margin obscurely tuberculose-striate, flesh white; lamellæ moderately close, narrowed toward the stem, at which a few of them are sometimes forked, adnate or slightly emarginate, white, the interspaces venose; stem equal, glabrous, stuffed or spongy within, white or reddish; spores white, globose, rough, .0003 to .00035 in. in diameter; taste mild.

Plant 1 to 1.5 in. high, pileus 1 to 1.5 in. broad, stem 2 to 4 lines thick.

Thin woods. Sandlake. June and July.

A small species, generally about 1 in. high, with the pileus about the same in breadth. Like the preceding species, to which it is closely related, it belongs to the white-spored group of the section FRAGILES, a group to which Europe contributes but a single mild species. The color of the pileus is nearly uniform and generally a pale-red or pinkish-red. The lamellæ in the fresh plant are white, but in the dried specimens they are pallid.

Hydnum albidum.

Pileus fleshy, thin, convex or nearly plane, subpruinose, white,

flesh white; aculei white; stem short, solid, central or eccentric, white; spores subglobose, .00016 to .0002 in. in diameter.

Plant 1 to 2 in. high, pileus 1 to 1.5 in. broad, stem 3 to 5 lines thick.

Ground in thin woods. Sandlake. June and July.

The species is closely allied to *Hydnum repandum*, with which it appears to have been united by some authors, but its small size, white color and smaller spores appear to me to make it worthy of specific distinction. It is quite unlike *Hydnum candidum*. The pileus is often irregular and lobed on the margin.

Clavaria divaricata.

Stem short, small, whitish, much branched; branches widely spreading, terete, even or slighty longitudinally wrinkled, more or less curved, pale-ochraceous, the ultimate ones tapering outward and terminating in one or more acute points; spores .0004 to .0005 in. long, .0002 to .00025 broad.

Tufts 2 to 4 in. high, and nearly as broad.

Woods. Sandlake. August.

This is a rare species, and is remarkable for and easily distinguished by its divaricate branches which give to the plant a very spreading, straggling aspect.

The following species were described in the Thirty-second Report of the State Museum, but owing to the limited edition and the incomplete manner (without plates) of the publication of that Report it has been thought best to repeat these descriptions here.

Clitocybe subhirta.

Pileus at first convex, then expanded or slightly depressed, tomentose-hairy and pale-yellow or buff, becoming subglabrous and whitish with age, the margin incurved; lamellæ close, adnate or decurrent, whitish or pale yellow; stem subequal, stuffed or hollow, whitish; spores subglobose or broadly elliptical, .0002 to .00025 in. long.

Plant 1 to 3 in. high, pileus 1 to 3 in. broad, stem 2 to 4 lines thick.

Woods. Brewerton. September.

The species belongs to the section Disciformes, and is near *Clitocybe subalutacea*, but distinct from it and all its other allies by the hairy pileus. Sometimes the hairs are more conspicuous on the margin than on the disk.

Collybia cremoracea.

Pileus thin, submembranous, convex or campanulate, obtuse, dry, slightly silky, dingy cream-colored, the margin sometimes wavy; lamellæ broad, ventricose, emarginate, with a decurrent tooth, whitish; stem slender, equal, slightly silky, stuffed or hollow, pallid or colored like the pileus; spores subglobose or broadly elliptical, about .00025 in. long, .0002 in. broad.

Plant 1.5 to 2 in. high, pileus 6 to 12 lines broad, stem 1 to 2 lines thick.

Thin woods. Gansevoort. August.

The species belongs to the section LÆVIPEDES.

Collybia hygrophoroides.

Plate 2. Figs. 23-26.

Pileus subconical, then convex or expanded, smooth, hygrophanous, reddish or yellowish-red when moist, paler when dry; lamellæ broad, subdistant, rounded behind or deeply emarginate, eroded on the edge, whitish; stem subequal, striate, stuffed or hollow, whitish; spores subelliptical, .0002 to .00025 in. long, .00016 in. broad.

Plant subcæspitose, 2 to 3 inches high, pileus 1 to 1.5 inches broad, stem 2 to 3 lines thick.

Decaying half-buried wood. Knowersville. May.

The young pileus resembles that of *Hygrophorus conicus*, both in shape and in color. When dry it becomes pallid or subochraceous. The species belongs to the section TEPHROPHANÆ.

Mycena luteopallens.

Pileus submembranous, convex, glabrous, striatulate on the margin when moist, bright-yellow, paler when dry; lamellæ subdistant, slightly arcuate, yellow; stem equal or slightly tapering upward, smooth, hollow, yellow, furnished at the base with yellow hairs and fibrils.

Plant scattered or cæspitose, about 2 in. high, pileus 3 to 6 lines broad, stem about 1 line thick.

Among fallen leaves in woods. Adirondack mountains. August.

It resembles *Hygrophorus parvulus* in color, but it is readily distinguished from that species by its subcæspitose mode of growth, its proportionately longer and more slender stem and the yellow hairs at its base.

Inocybe eutheloides.

Pileus thin, broadly conical or campanulate, becoming nearly plane with age, distinctly umbonate, silky-fibrillose, more or less rimose, varying in color from grayish-cervine to chestnut-brown, the disk sometimes squamulose, the flesh white; lamellæ moderately close, rather broad, ventricose, narrowed or rounded behind, adnexed, whitish, becoming ferruginous-brown, white and denticulate on the edge; stem equal, subflexuous, solid, fibrillose, whitish or pallid; spores even, uninucleate, subelliptical, .00035 to .00045 in. long, .00025 to .0003 in. broad.

Plant 1 to 2 in. high, pileus 6 to 12 lines broad, stem 1 to 2 lines thick.

Woods. Brewerton. September.

The species belongs to the section Rimosi. It agrees in many respects with the description of *Inocybe eutheles*, but differs in the character of the lamellæ, which are rather abruptly and strongly narrowed behind and adnexed, not adnate. The spores are longer than in that species and the plant is destitute of a farinaceous odor. The pileus is sometimes scarcely rimose and it varies considerably in color. The stem is decidedly paler than the pileus.

Inocybe infelix.

Pileus thin, subcampanulate, then convex or expanded, umbonate, fibrillose-squamulose, umber-brown or grayish-brown, flesh white; lamellæ close, rather broad, ventricose, emarginate, whitish, becoming ferruginous-brown; stem equal, solid, silky-fibrillose, whitish or pallid, pruinose above; spores oblong, even, .00045 to .0006 in. long, .0002 to .00025 in. broad.

Plant 1 to 2 in. high, pileus 6 to 12 lines broad, stem 1 to 2 lines thick.

Sterile or mossy ground. Indian lake, Adirondack mountains. August.

The species belongs to the section Laceri. The pileus is more lacerated in wet weather than in dry, and generally becomes paler with age. A small form, variety *brevipes*, has the pileus 4 to 6 lines broad and but slightly umbonate, and the stem scarcely more than half an inch long. Sometimes the stem is white above and darker toward the base. The long narrow spores constitute a marked feature of the species.

Myxacium amarum.

Pileus thin, convex or nearly plane, often irregular, smooth, glutinous, yellow, the disk often tinged with red, the margin whitish, flesh white, taste very bitter; lamellæ close, rounded behind, whitish, becoming ochraceous-cinnamon; stem soft, viscid in wet weather, solid, tapering upward, whitish, clothed with silky white fibrils; spores elliptical, .0003 to .0004 in. long, .0002 to .00025 broad.

Plant gregarious or subcæspitose, 1 to 2 in. high, pileus about 1 in. broad, stem 2 to 4 lines thick.

Under spruce and balsam trees. Adirondack mountains. August.

The very bitter taste is suggestive of the specific name. The stem is scarcely viscid except in wet weather.

Russula compacta *Frost MS.*

"Pileus white, firm, solid, cracked in age, sometimes tinged with red or yellow or both in spots, turning up in age, seldom depressed; lamellæ very white, almost free, not forked or dimidiate, becoming brown when bruised or dry; stem solid, white, even, smooth; flesh at first white, then brownish."

Pileus fleshy, compact, convex or centrally depressed, whitish, sometimes tinged with red or yellow, becoming reddish-alutaceous or dingy-ochraceous with age, the margin thin, even, incurved when young; lamellæ rather broad, subdistant, nearly free, some of them forked, a few dimidiate, white, becoming brown with age or where bruised; stem short, equal, firm, solid, white, changing color like the pileus; spores subglobose, nearly even, .00035 in. in diameter.

Plant 2 to 4 in. high, pileus 3 to 5 in. broad, stem 8 to 12 lines thick.

Open woods. Sandlake and Brewerton. August and September.

The late Mr. C. C. Frost sent me specimens and manuscript descriptions of a few species of fungi collected by him in Vermont. He gave names to those which he considered new species, and it gives me pleasure to adopt his names whenever it is rendered possible by the discovery of the species within our limits. The plant here described does not fully agree with his manuscript description, which I have quoted, but it approaches so near an agreement that there cannot be much doubt of the specific identity of the two plants. In our plant the pileus is sometimes split on the margin. The change in the color of the pileus and stem is nearly the same, but the lamellæ sometimes become darker than either. When drying, the specimens emit

a strong and very disagreeable odor. The species belongs to the section COMPACTÆ.

Russula flavida *Frost MS.*

"Pileus fleshy, convex, slightly depressed, unpolished, bright-yellow; lamellæ white, adnate, turning cinereous; stem yellow, solid, white at the extreme apex."

Pileus fleshy, convex, then plane or slightly depressed, yellow, becoming paler with age, flesh white, taste mild, the margin at first even, then tuberculate-striate; lamellæ nearly simple, subdistant and broader before, adnate, white, the interspaces venose; stem short, equal or tapering upward, firm, glabrous, solid or merely spongy within, yellow; spores globose, .00025 to .0003 in. in diameter.

Plant gregarious, 1 to 2 in. high, pileus 1 to 2 in. broad, stem 4 to 6 lines thick.

Grassy places in copses and open woods. Sandlake. July.

The species belongs to the section RIGIDÆ. The pileus is dry and sometimes slightly mealy or granular. When young it is bright-yellow, but it fades with age and sometimes becomes white on the margin.

Boletus rubinellus.

Plate 2. Figs. 20–22.

Pileus at first broadly conical or subconvex, then nearly plane, subtomentose, red, becoming paler with age; tubes convex, adnate or slightly depressed about the stem, rather large, subrotund, pinkish-red, becoming sordid-yellow; stem equal, smooth, yellow with reddish stains; spores oblong-fusiform, .0004 to .0005 in. long, .00016 broad.

Plant about 2 in. high, pileus 1 to 2 in. broad, stem 2 to 3 lines thick.

Woods. Gansevoort. August.

Apparently related to *B. rubinus*, and also resembling *B. piperatus*, but the stem is differently colored, and I have not found the pileus at all viscid.

Tremella subcarnosa.

Small, tufted, compressed, irregular, wavy or contorted, subcarnose, externally gelatinous, whitish or pinkish-alutaceous, becoming brownish-incarnate and somewhat glaucous when dry; spores obovate, pointed at one end, .0002 to .0003 in. long, .00016 broad.

Tufts 2 to 4 lines high and about as broad.

Decaying wood of deciduous trees. Carlisle. June.

The affinities of this fungus are doubtful. It is provisionally referred to the genus Tremella, although the central part of the substance is fleshy rather than gelatinous. The plants revive on the application of moisture and when moist are somewhat tremelloid. The tufts form beautiful little rosettes.

Grandinia membranacea *P. & C., n. sp.*

Effused, thin, membranaceous, whitish or subalutaceous, sometimes slightly tinged with greenish-yellow or olivaceous; granules numerous, crowded, unequal; spores broadly elliptical or subglobose, slightly rough, .00025 to .0003 in. long.

Much decayed wood, leaves, etc. Tonawanda. G. W. Clinton.

Apparently related in texture to *G. papillosa*, but differing in color and in its even, not rimose, hymenium.

Phoma callospora *P. & C., n. sp.*

Perithecia small, scattered, slightly prominent, covered by the epidermis, black; spores oblong or cylindrical, obtuse, straight or curved, containing 3 to 5 nuclei, .0006 to .0008 in. long, .0002 to .00025 broad.

Dead stems of Polygonum. Buffalo. October. G. W. Clinton.

Phoma cornina.

Perithecia numerous, not crowded, minute, nearly covered by the stellately ruptured epidermis, black, opening by a large pore; spores oblong, obtuse, .0012 to .0016 in. long, .0005 to .00055 broad.

Dead branches of green osier, *Cornus circinata*. Sprakers. June.

This and the preceding species are erroneously referred to the genus Sphæropsis in the Thirty-second Report.

Sphæropsis typhina.

Perithecia scattered, subconical, slightly prominent, often compressed; spores fusiform, pointed at each end, colored, .0006 in. long, .00016 broad.

Dead leaves of *Typha latifolia*. Sprakers. June.

The fusiform pointed spores constitute a noticeable character in this species.

Protomyces conglomeratus.

Spores imbedded in the tissues of the stems of the host plant, large, globose, colored, .0016 to .002 in. in diameter, aggregated in

groups or clusters and forming small protuberances or tubercles on the dry stems.

Common saltwort, *Salicornia herbacea.* Syracuse. September.

The species is remarkable for the large size of the spores and their clustered mode of growth.

Periconia albiceps.

Plate 1, figs. 8–11.

Stems short, .02 to .03 in. high, equal or slightly tapering upward, black; head subglobose, white; spores oblong or subfusiform, colorless, .0003 to .0006 in. long.

Dead stems of balmony, *Chelone glabra.* Sandlake. May.

The stems of the fungus are composed of compacted filaments, and I have followed the English mycologists in referring the species to the genus Periconia. It is Sporocybe of Bonorden.

Gonatobotryum tenellum.

Patches thinly effused, subolivaceous; flocci subtufted, erect, slender, simple or rarely branched, not nodulose-inflated, septate, brown, .006 to .014 in. high; spores in verticels of 2 to 4 at the septa, oblong, simple, subfuliginous, .00045 to .0005 in. long, .00016 to .0002 broad.

Dead stems of stoneroot, *Collinsonia Canadensis.* North Greenbush. October.

By reason of the equal, not nodulose, flocci the species does not well agree with the character of the genus. Because of the colored flocci it would go no better in Arthrinium.

Ramularia effusa.

Hypophyllous, often occupying the whole lower surface of the leaf, whitish; spores very variable, globose, obovate-elliptical, oblong or cylindrical, .00016 to .0011 in. long, .00016 to .0002 broad, sometimes uniseptate.

Living leaves of black huckleberry, *Gaylussacia resinosa.* Karner. July.

Sometimes all the leaves on a branch have the lower surface whitened by this fungus.

Ramularia albomaculata.

Spots suborbicular, 2 to 3 lines in diameter, sometimes confluent, pale yellowish-green on the upper surface, becoming purplish

or brown with age, whitened by the fungus below; spores oblong or elliptical, generally binucleate, .0003 to .0004 in. long, .00016 broad.

Living leaves of hickory, *Carya alba.* Albany and Greenbush. June and July.

Sometimes the spots are angular, being limited by the veinlets of the leaf. In this species and in the next one I have not seen the spores septate, but suspecting that the nuclei indicate septa in more mature specimens, I have referred the species to this genus for the present. They may belong rather to Cylindrium or Fusidium.

Ramularia angustata.

Spots small, orbicular, sometimes confluent, pale greenish-yellow, becoming reddish-brown or brown, frosted on the lower surface by the fungus; flocci minute; spores narrowly fusiform or subcylindrical, .0003 to .0004 in. long, about .0001 in. broad, often containing two or three nucleoli.

Living leaves of pinxter plant, *Azalea nudiflora.* Central Bridge and Carlisle. June.

The very narrow spores suggest the specific name.

Ramularia lineola.

Spots suborbicular, sometimes confluent, brown, concentrically lineolate; flocci obscure, tufted, hypophyllous; spores slender, cylindrical, obtuse, .0005 to .0008 in. long, often uniseptate.

Living leaves of dandelion, *Taraxacum, Dens-leonis.* Greenbush. July.

The fungus is so minute that it is scarcely visible to the naked eye.

Sporotrichum larvicolum.

Flocci slender, simple or branched, forming a continuous, dense, soft, white or yellowish stratum coating the whole matrix; spores abundant, minute, globose, .00008 to .00012 in. broad.

Dead larvæ lying on the ground under alders. Adirondack mountains. July.

The larvæ were very numerous and, but for the check imposed upon the increase of the species by the attacks of this fungus, they would probably in a short time have completely defoliated all the alders in that locality. In some specimens the fungus spores were so abundant that the surface of the stratum had a pulverulent appearance.

Acremonium flexuosum.

Plate 1, figs. 16–18.

Flocci procumbent, interwoven, branched, forming a thin, soft, tomentose, white or cream-colored stratum, the branches widely divergent, sometimes opposite, narrowed and flexuous toward the tips and bearing scattered, alternate spicules or sporophores ; spores oval or elliptical, .0005 to .0008 in. long, .0003 to 0005 in. broad.

Decaying wood. Griffins, Delaware county. September.

From *Acremonium album* it differs in habit and habitat, as well as in the flexuous terminal portions of the flocci and their alternate pointed spicules ; and from *Acremonium alternatum* it is distinguished by its elliptical spores.

Sepedonium brunneum.

Effused, pulverulent, brown ; spores globose, rough, .0008 to .001 in. in diameter.

Decaying fungi. Gansevoort. August.

This is similar in habit to *Sepedonium chrysospermum*, from which its dark snuff-brown spores distinguish it. Like that fungus, this is also probably a mere state of some species of Hypomyces.

Morchella angusticeps.

Plate 1, figs 19–21.

Pileus narrowly conical or oblong-conical, acute or subobtuse, 1 to 2 in. long, its diameter at the base scarcely exceeding that of the stem, pale-buff or cream-colored, adnate, sometimes a little curved, the costæ longitudinal, anastomosing or connected by transverse veins ; stem subequal, hollow, furfuraceous, even or sometimes marked by irregular longitudinal ridges and furrows, whitish, about equal to the pileus in length ; asci cylindrical ; spores elliptical, yellowish, .0008 to .001 in. long, .0005 to .0007 broad.

Borders of woods and open places. Albany and Karner. April and May. Edible.

This morel is perhaps too closely related to *Morchella conica* Pers., but if that species is correctly represented in Mycographia, plate 81, fig. 315, our plant is easily distinguished by its much more narrow pileus, which scarcely exceeds the stem in diameter. The paraphyses of that species are also represented as filiform, and are described (l. c. p. 182) as thickened above. In our plant I find no such paraphyses, but instead of them there are oblong or subclavate

bodies much shorter than the asci, but nearly as broad. They are often filled with large, unequal, crowded nuclei, and appear more like undeveloped asci than like ordinary paraphyses. The interior surface of the stem is scurfy like the exterior.

Peziza orbicularis.
Plate 2, figs. 4–6.

Receptacle 8 to 12 lines broad, sessile, appressed to the matrix, nearly plane, orbicular or sometimes irregular, externally whitish or subolivaceous and slightly gelatinous when moist, the disk reddish-brown or chestnut-colored; asci cylindrical; spores uniseriate, elliptical, .0009 to .0011 in. long, .00045 to .0005 in. broad; paraphyses filiform, thickened at the tips, brownish.

Wet, much decayed wood. Brewerton and Guilderland. September and October.

The spores usually contain one or two large nuclei. The contrast between the dark color of the disk and the light color of the external surface is quite noticeable. The flattened orbicular form of the receptacle when growing on smooth surfaces suggests the specific name. In the Thirty-second Report both this and the next species were referred to the genus Bulgaria under the respective names *B. bicolor* and *B. deligata*, but upon further observation their affinities appear to me to bring them in the genus Peziza, subgenus Discina, in consequence of which I am obliged to change the names.

Peziza leucobasis.
Plate 2, figs. 1–3.

Receptacles 1 to 3 lines broad, scattered or crowded, plane or convex, sessile, scarcely margined, purplish-black when moist, black and more or less angular when dry, surrounded at the base by dense whitish filaments; asci cylindrical, .01 to .012 in. long, .0009 to .001 broad; spores uniseriate, elliptical, even, binucleate, subhyaline, .001 to .0013 in. long, .0006 to .0007 broad; paraphyses numerous, filiform, septate, colored, slightly thickened above.

Wet, decaying hemlock wood. Catskill mountains. July.

The numerous white filaments that appear to bind the receptacles to the matrix, constitute a marked feature in this species and suggest the specific name.

Peziza longipila.
Plate 2, figs. 15–19.

Receptacle small, .014 to .02 in. broad, narrowed below into a short stem, densely clothed with long, rigid, erect, septate, tawny-

brown hairs, the uppermost .01 to .014 in. long, .0003 broad, the disk whitish, concealed in the dry plant by the hairs of the margin; asci cylindrical, .0025 to .003 in. long, .00025 to .0003 broad; spores oblong or subfusiform, straight or slightly curved, colorless, .0003 to .0004 in. long, .00008 to .00012 broad.

Dead stems of *Eupatorium maculatum.* Adirondack mountains. July.

Apparently near *P. relicina* Fr., but that is described as sessile and of a bay color.

This and the next following species belong to the subgenus Dasyscypha.

Peziza urticina.

Receptacle minute, .007 to .014 in. broad, sessile, subglobose, almost hyaline, and with the mouth connivent when moist, whitish and pulverulent-hairy when dry; asci subfusiform; spores crowded or biseriate, fusiform, .0004 to .0005 in. long; paraphyses filiform.

Dead stems of nettles, *Laportea Canadensis.* Catskill mountains. July.

When moist the hairs are appressed and the cups appear longitudinally striate. When dry the disk is generally concealed. The plants are so small that they appear to the naked eye like minute white grains.

Helotium fraternum.

Plate 1, figs. 12–14.

Receptacle small, ½ to 1 line broad, stipitate, the disk plane or slightly concave, pallid or reddish-yellow, becoming more concave and dull-red in drying, the stem about equal in length to the diameter of the receptacle; asci clavate or subcylindrical, .003 to .004 in. long, .0004 to .0005 broad; spores crowded or biseriate, subcylindrical, .00065 to .0008 in. long, .00016 to .0002 broad; paraphyses numerous, filiform, scarcely thickened at the tips.

Petioles and midveins of fallen leaves of maple, *Acer saccharinum.* Adirondack mountains. July.

Pezicula minuta.

Receptacle minute, .009 to .017 in. broad, numerous, scattered or two or three crowded together, attached to the matrix by a minute point, grayish, pulverulent, the margin obtuse or obsolete, the disk plane or convex, subochraceous; asci oblong-clavate; spores crowded,

oblong-elliptical, colorless, .0008 to .001 in. long; paraphyses filiform, thickened at the apex.

Dead stems of hobble bush, *Viburnum lantanoides.* Catskill mountains. July.

Ascophanus tetraonalis.

Receptacle sessile, 1 to 2 lines broad. externally cinereous, the margin sometimes wavy or flexuous, the disk blackish or blackish-brown; asci cylindrical, truncate at the apex; spores uniseriate, elliptical, smooth, colorless, .0006 to .0007 in. long, .0003 broad.

Excrement of partridges or ruffed grouse. Catskill mountains. July.

The receptacles are about equal in size to those of *Ascophanus gallinaceus*, which has a similar habitat, but a paler color and shorter spores. This and the next following species were erroneously referred to the genus Peziza in the Thirty-second Report.

Ascophanus humosoides.

Receptacles small, scarcely more than half a line broad, sessile, scattered or crowded, orange-colored inclining to vinous-red, the disk plane or slightly convex, slightly margined; asci short, cylindrical or clavate; spores crowded or elliptical, even, .0008 to .001 in. long, .0005 broad; paraphyses filiform, slightly thickened above.

Excrement of some wild animal. Catskill mountains. July.

The cups are attached to the matrix by a few white filaments.

Patellaria pusilla.

Receptacle small, .014 to .028 in. broad, sessile, slightly margined, black, the disk plane or convex when moist, slightly concave when dry; asci clavate; spores crowded or biseriate, subclavate, .00065 to .0008 in. long, .0001 to .00012 broad, six to eight nucleate; paraphyses numerous, filiform.

Decaying beech wood. Catskill mountains. July.

The spores are similar in shape to those of *P. atrata.* They are extremely narrow and probably become five to seven-septate when mature.

Acanthostigma scopula.

Perithecia small, .006 to .008 in. broad, subglobose, very black, bristly with short, rigid, divergent black hairs or setæ which are .003 to .005 in. long, .00016 to .0002 thick; asci lanceolate or subclavate; spores crowded or biseriate, elongated, gradually narrowed

toward each end, straight or slightly curved, multinucleate, at length obscurely multiseptate, greenish-yellow, .0025 to .003 in. long, .00012 to .00016 broad.

Decaying wood of hemlock. Adirondack mountains. August.

This is *Sphæria scopula* C. & P. in the Thirty-second Report. It is here referred to the genus Acanthostigma because of the shape of the spores. From *A. Clintonii* it may be distinguished by its larger perithecia and longer spores.

Lasiosphæria intricata.

Perithecia scattered or crowded, somewhat elongated, .025 to .035 in. long, .018 to .02 broad, generally narrowed toward the base, obtuse, subfragile, tomentose-hairy, brown or blackish-brown; subiculum very thin or none; asci slender, elongated, .005 to .008 in. long, .0004 to .0005 broad; spores crowded, linear, curved or flexuous, greenish-yellow, .0016 to .0025 in. long, .00016 to .0002 broad.

Decaying wood and leaves in damp places. Sandlake.

The species belongs to the section LEPTOSPORA. The perithecia, though small, resemble in shape those of *Bombardia fasciculata*. The minute papillate ostiolum is often concealed by the tomentum of the perithecia. This is composed of intricate, matted, slender, septate, brown filaments, which, by their soft, tomentose character, readily distinguish this species from the related *L. strigosa*, *L. hispida*, *L. hirsuta*, etc.

Herpotrichia leucostoma.

Perithecia small, .012 to .018 in. broad, numerous, somewhat crowded, subglobose, seated upon or involved in a blackish-brown tomentum, the ostiola naked, not prominent, whitish when moist, grayish or sordid when dry; asci cylindrical or subclavate, .006 to .008 in. long, .0004 to .0006 broad; spores crowded or biseriate, oblong-fusiform, at first uniseptate, constricted at the septum and containing two or three nuclei in each cell, then three to five-septate, colorless, .0015 to .002 in. long, .0003 to .00035 in. broad.

Dead branches of mountain maple-bush, *Acer spicatum*. Catskill mountains. September.

The whitish ostiola constitute a marked feature in this species. It is distinguished from *Herpotrichia Schiedermayeriana* Fckl. by its much smaller perithecia, and the more numerous septa of the spores. I have observed no globose appendages at the ends of the spores in

our plant. The threads of the subiculum are obscurely septate and sometimes slightly branched. The more classical name " leucostoma " is here substituted for " albidostoma."

Zignoella humulina.

Perithecia small, .011 to .014 in. broad, depressed-hemispherical, slightly sunk in the matrix, subglabrous, black, with a minute papillate ostiolum ; asci cylindrical, .0025 to .003 in. long, .0003 to .0004 in. broad ; spores uniseriate or obliquely monostichous, elliptical, four-locular, appearing obscurely triseptate, colorless, .0005 to .0006 in. long, .00025 to .0003 in. broad.

Dead stems of hops, *Humulus lupulus*. Carlisle. June.

The spores are not distinctly triseptate, and the species apparently belongs to the subgenus Zignoina. The perithecia have a dull, squalid, unpolished or subscabrous appearance.

Acrospermum album.

Perithecia elongated, subfusiform, somewhat compressed, pointed at the apex, narrowed below into a short, terete, stem-like base, white ; spores very long, filiform.

Dead stems of spikenard, *Aralia racemosa*. Catskill mountains. July.

This resembles *A. compressum* in size, but it is at once distinguished from that and other related species by its persistently white color.

ADDITIONS, REMARKS AND OBSERVATIONS.

The first fourteen species of the following list are additions to our State flora, and have not before been reported.

Hieracium Pilosella *L.*

Door yards. Aurora, Cayuga county. *C. Atwood, M. D.*

This plant has been introduced from Europe, and is yet scarce and perhaps not thoroughly established.

Atriplex hortensis *L.*

Roadsides. High Bridge, Onondaga county. *Mrs. S. M. Rust* and *Mrs. C. Barnes.*

Probably a stray from cultivation, and perhaps not permanently established.

Amanita pantherina *DC.*

Thin woods. Sandlake, Rensselaer county. July.

According to the figure and description of this species the pileus is brown or brownish, but in all our specimens it is white or merely tinged with brown on the disk. In other respects they agree so well with the description that there can be no doubt of their specific identity. They afford a striking instance of the tendency in some of our American forms to depart from the color of the European plant. The different character of its volva will distinguish it from white forms of *A. muscarius*, and the warts on the pileus and annulus on the stem will separate it from *A. nivalis.*

Clitocybe phyllophila *Fr.*

Among fallen leaves in woods. Karner. September.

Clitocybe pithyophila *Fr.*

Among fallen leaves in woods. Sandlake.

Collybia aquosa *Bull.*

Among sphagnum. Karner. October.

In our specimens the lamellæ, instead of being rounded behind and free, according to the description of the species, are adnate or

slightly decurrent. They are therefore designated, variety *adnatifolia*. In drying, the moisture escapes from the thicker, central part of the pileus sooner than from the thin margin.

Mycena clavicularis *Fr.*

Under pine trees. Sandlake. June.

Psilocybe bullaceus *Fr.*

Manured ground. Sandlake. July.

Lactarius cilicioides *Fr.*

Sandy soil. West Albany. October.

A small, white form with very sparse milk.

Hygrophorus virgineus *Fr.*

Roadsides and grassy fields. Sandlake. August.

Cortinarius cinnabarinus *Fr.*

Thin woods and bushy places. Sandlake. June.

Hydnum scrobiculatum *Fr.*

Woods. Sandlake. July.

The disk is sometimes very uneven with irregular prominences.

Valsa sepincola *Fckl.*

Dead stems of raspberry, *Rubus strigosus*. Karner. October.

Cryptospora Betulæ *Tul.*

Dead bark and twigs of white birch, *Betula populifolia*. Karner. October.

Ampelopsis quinquefolia *Mx.*

Specimens sometimes occur with some of the leaves trifoliate.

Geranium Robertianum *L.*

A white-flowered form. Isley island, Sodus Bay, Wayne county. *F. W. Battershall.*

Galium lanceolatum *Torr.*

A white-flowered form. Sandlake.

Rhodora Canadensis *L.*

Thirteenth pond, Johnsburgh, Warren county. May. *Mrs. I. B. Sampson.*

The specimens are in flower, but the leaves had not yet developed. The original herbarium specimens bear old capsules, but no leaves,

so that leaf-bearing specimens are yet wanting. I do not find this plant recorded in any of the local catalogues of plants of various parts of the State, and Dr. Torrey admitted it in the New York Flora with the following explanatory remark: "I am not quite certain that I have received specimens of this plant from within the limits of the State; but it doubtless grows in some of the northern counties." The result has proved the accuracy of his supposition, but the plant is evidently rare in our State.

Potamogeton pauciflorus *Pursh.*

A peculiar form of this species occurs in Glass lake, Rensselaer county. The stems are 1 to 2 feet long, the spikes numerous and axillary and the foliage of a dull-brownish or reddish-brown color, quite unlike the ordinary bright-green hue of the species.

Pogonia affinis *Aust.*

In a swamp near Tappantown, Rockland county. June. *E. F. Smith.*

Juncus Canadensis var. **coarctatus** *Engelm.*

This plant sometimes has the flower heads wholly or in part changed to enlarged leafy buds, or rather galls, for they are produced by the attacks of insects.

Clitopilus Noveboracensis *Pk.*

Sometimes the pileus is dark-brown, much darker than in the typical form. There is also a variety *tomentosipes*, in which the stem is clothed with a whitish or grayish hairy tomentum. The plants are also sometimes cæspitose. Sandlake. July.

Entoloma strictior var. **isabellinus** *Pk.*

Pileus, when moist, of a watery isabelline hue and striatulate on the margin, when dry, whitish or pale straw color.

Sphagnous marshes. Sandlake. August.

Clavaria amethystina *Bull.*

Woods. Sandlake. July.

Sometimes the color inclines to a grayish-violaceous hue. Both the small sparsely branched and the abundantly branched forms occur.

Dacrymyces conglobatus *Pk.*

Plate 1, figs. 1–4.

In the Thirty-second Report, this was provisionally referred to the genus Dacrymyces. It is apparently *Peziza rubella* Pers., and *Om-*

brophila rubella Quel., which is figured in Tabulæ Analyticæ Fungorum, by M. Patouillard, Fasc. 11, fig. 157. But unless it shall yet be found to have an ascigerous form it can not well be received in either of these genera. It may yet be necessary to institute a genus for its reception.

Glomerularia Corni *Pk.*

Plate 2, figs. 10–14.

This species was originally found on leaves of dwarf cornel, *Cornus Canadensis.* It also occurs in the Adirondack forests on leaves of fly honeysuckle, *Lonicera ciliata.* On this host it forms extensive patches, sometimes occupying nearly the whole leaf, and its filaments are more highly developed. It has been described in Sylloge Fungorum, vol. IV, p. 10.

Geoglossum irregulare *Pk.*

Plate 1, figs. 5–7.

A description of this fungus is contained in Revue Mycologique, 1882, p. 212, under the name *Geoglossum vitellinum* Bres. Owing to the imperfect publication of the Thirty-second Report it will be better to adopt this later name.

Helotium vibrisseoides *Pk.*

Plate 2, figs. 7–9.

In 1881 this fungus was published under the name of *Vibrissea turbinata* Phillips. It is *Gorgoniceps turbinata* Sacc., a name which should be adopted for the reason already given.

NEW YORK SPECIES OF PAXILLUS.

PAXILLUS *Fr.*

"Hymenophorum continuous with the stem, decurrent. Lamellæ membranous, scissile, somewhat branched and often anastomosing behind, *distinct from the hymenophorum and easily separable from it.* Spores sordid-whitish or ferruginous.

"*Fleshy putrescent fungi continuously and gradually unfolding and expanding from an involute margin.*" *Hymen. Europ.*, p. 400.

The species of this genus are related to the Agarici on one hand, and to the Boleti on the other. The important distinguishing character is afforded by the lamellæ, which are easily and smoothly separable from the pileus, just as the tubes of a Boletus are from the pileus that supports them. This relationship between the Paxilli and Boleti is still further indicated by the anastomosing of the lamellæ, which in one species, *Paxillus porosus*, is carried to such an extent that the hymenium is as distinctly porous as it is in some Boleti. On the other hand, the close relationship that exists between this genus and the genus Agaricus may be inferred from the fact that *Agaricus personatus* and *A. cinerascens* are still retained by Fries among the Agarici, although he makes the remark that they belong rather to the Paxilli. In the second edition of Epicrisis he has modified the diagnosis of the genus, and at the same time admitted that it is "not yet correctly defined." Neither is the limitation of the two tribes into which he divides the species very satisfactory, for a central stem and sordid spores, characters assigned to Lepista, are not always associated together, nor are ferruginous spores found only in species with the stem commonly lateral or eccentric. It has, therefore, seemed best to me, for the present, to refer to this genus such species only as have the spores colored and the separable lamellæ more or less branched, crisped or anastomosing. This reduces our species to five, three of which are found also in Europe. They grow chiefly in woods and occur in the latter part of summer and in autumn. The separable character of the hymenium can only be ascertained by the mutilation of a specimen.

Synopsis of the Species.

1 Hymenium clearly lamellate.	2.
2 Pileus white, stem present.	P. simulans.
2 Pileus colored.	3.
3 Stem glabrous.	P. involutus.
3 Stem densely hairy.	P. atrotomentosus.
3 Stem none.	P. panuoides.
1 Hymenium wholly porous.	P. porosus.

Paxillus simulans *n. sp.*

Simulating Paxillus.

Pileus broadly convex, expanded or subinfundibuliform, compact, subglabrous, even or somewhat scabrous-pustulate, *white or whitish*, the involute margin often tomentose-hairy, flesh white; lamellæ close, forked, crisped near the stem, adnate or decurrent, *white, then ochraceous-yellow tinged with salmon color*; stem *central*, short, firm, equal, *stuffed or hollow*, pubescent, white; spores pale ochraceous-yellow, subglobose or broadly elliptical, .0002 to .0003 in. long, .0002 in. broad.

Plant 1 to 3 in. high, pileus 2 to 4 in. broad, stem 6 to 12 lines thick.

In thin woods. Sandlake. July. Rare.

A large species externally resembling *Lactarius vellereus*, and perhaps hitherto confused with it, but easily distinguished from it by the absence of a milky juice and by the lamellæ which are crisped near the base and which soon assume a peculiar salmon-yellow hue, which also appears in the spores when collected on white paper. This change of color begins in the crisped portion near the stem and gradually advances toward the outer extremity. In the dried specimens the lamellæ are ochraceous-brown and they have the edge more or less beaded with white granules. They are often forked near the outer extremity as well as toward the inner. The length of the stem sometimes scarcely exceeds its breadth. In but a single instance was it eccentric, and in that case the pileus was lobed and irregular. The surface of the pileus is sometimes roughened with minute pustules or papillæ and sometimes has a pitted appearance. Rarely the margin is obscurely zonate. The taste is bitterish and unpleasant, and some times the plant emits a subacid odor. It is a singular species.

Paxillus involutus *Fr.*

Involute Paxillus.

Pileus compact, convex or expanded, sometimes centrally depressed, glabrous, *viscid when moist*, varying in color from grayish

or sordid-buff to ferruginous or brownish-ochraceous, the margin at first *strongly involute and covered with a dense grayish tomentose villosity*, flesh grayish-white or pallid; lamellæ close, decurrent, branched and anastomosing behind, whitish, then yellowish or subferruginous, becoming reddish-brown or fuscous where cut or bruised, the interspaces venose; stem equal or slightly thickened at the base, central or sometimes eccentric, glabrous, solid; spores elliptical, .0003 to .0004 in. long, .0002 to .00025 in. broad.

Plant 2 to 4 in. high, pileus 2 to 4 in. broad, stem 4 to 8 lines thick.

In woods on the ground and on decaying wood. Common in the Adirondack mountains and not rare in the mixed woods of all our hilly districts. August to November.

This species is said, by Fries and other authors, to be edible. but I have not tested its edible qualities. It is said to be held in high estimation as an article of food in Russia. It is somewhat solitary in its mode of growth and prefers a soil chiefly composed of vegetable mold. Damp shaded mossy banks and deep hemlock and spruce woods are favorite habitats for it. It sometimes grows on much decayed stumps and old prostrate trunks of trees. In such cases the stem is sometimes eccentric, but when growing on the ground it is almost always central, though Fries places the species in the tribe Tapinia. Neither do the spores of our plant agree well with the dimensions given in the Handbook of British Fungi, still it does not appear to me to be specifically distinct. The pileus is generally regular in outline and, when expanded, bears upon its margin short, distant and somewhat irregular striations. The hairiness of the margin is more distinct in the young plants. The color of the pileus is not very decided, being somewhat variable, and a peculiar mixture of gray, ochraceous, ferruginous and brown. The surface is sometimes opaque, sometimes shining. The lamellæ and often other parts of the plant change color when cut or bruised. In drying, the lamellæ of this and also of the preceding and the two following species frequently assume a smoky-brown or blackish hue.

Paxillus atrotomentosus *Fr.*

Dark-Downy Paxillus.

Pileus compact, convex, then expanded or centrally depressed, varying from subglabrous to scabrous-granulose, sometimes tomentose-hairy on the disk, often minutely rivulose, ochraceous-red, ferruginous-brown or reddish-brown, the margin sometimes paler, flesh

white; lamellæ close, rather broad, adnate or slightly decurrent, somewhat branched and anastomosing at the base, pale creamy-yellow, the interspaces venose; stem firm, stout, solid, eccentric or lateral, rarely central, *densely tomentose-hairy, dark-brown;* spores elliptical, .0002 to .00025 in. long, .00016 in. broad.

Plant single or cæspitose, 3 to 6 in. high, pileus 3 to 6 in. broad, stem 6 to 15 lines thick.

Ground and much decayed wood of pine and hemlock. Helderberg mountains, Sandlake and Gansevoort. August.

This is a large species, easily recognized by the dark-brown coarsely velvety or densely hairy coat of the stem, which character is suggestive of the specific name. It sometimes grows in large tufts, and then the pileus is frequently irregular by reason of mutual compression. In wet weather the pileus is moist and sometimes obscurely mottled with dark spots. Occasionally it emits an unpleasant, dirt-like odor.

Paxillus panuoides *Fr.*

Panus-like Paxillus. Stemless Paxillus. Pale Paxillus.

Pileus fleshy, thin, convex or nearly plane, *sessile* or resupinate, sometimes narrowed behind into a short stem-like base, pubescent or glabrous, yellowish or brownish-yellow; lamellæ narrow, close, anastomosing and crisped at the base, yellow; spores subglobose or broadly elliptical, .00018 to .0002 in. long, .00013 to .00016 in. broad.

Pileus 1 to 2 in. broad and long.

Decaying wood, usually of pine and hemlock. Albany, Maryland and Adirondack mountains. August and September.

This is our only sessile species. It grows in open places as well as in woods. It is quite variable in Europe, according to the description in Hymenomycetes Europæi. A form with a whitish pileus (*Agaricus lamellirugis* Dec. Fl., *Merulius crispus* Turpin) is the variety B of Fries. A form with a resupinate cup-like pileus, variety *pezizoides*, is his variety C, and *Gomphus pezizoides* Pers. The Handbook also describes a form with a white pileus tinged with violet. Of these, only the var. *pezizoides* has been found here. It occurs in the Adirondack mountain region.

Paxillus porosus *Berk.*

Porous Paxillus.

Pileus fleshy, broadly convex or expanded, often irregular or subreniform, dry, glabrous or minutely tomentose, reddish-brown, some-

times ochraceous-brown, flesh yellowish; lamellæ *wholly connected by numerous narrow transverse branches, causing the hymenium to consist of large angular pores*, decurrent, bright-yellow; stem short, hard, eccentric or lateral, generally reticulated above, colored like the pileus; spores elliptical, uninucleate, .00035 to .00045 in. long, .00024 to .00032 in. broad.

Plant 1 to 2 in. high, pileus 2 to 4 in. broad, stem 3 to 6 lines thick.

Ground in woods and open places. Sandlake, Oneida, Brewerton and Catskill mountains. August.

A singular species remarkable for its boletoid or porous hymenium. It is thus far peculiar to this country. Its spores, according to Prof. A. P. Morgan, are bright-yellow. They are larger than in any of our other species of Paxillus. The author of the species makes the remark that "without examining the fructification it might be taken for a *Boletus*." It is admitted that the spores are broader in proportion to their length than are the spores of most Boleti, but in *Boletus strobilaceus* the spores make quite as wide a departure from the ordinary form. In fresh specimens the radiating lamellæ are distinguishable, being somewhat broader than the connecting veins or branches, but in the dried specimens this difference is so obscured that the hymenium appears in no manner to differ from that of some of the large and angular-pored Boleti. Indeed this same kind of union of radiating lamellæ is discernible in the hymenium of *Boletus paluster* in which the spores approach much more closely to the ordinary form of Boletus spores; from which it may be inferred that if the species just described is a genuine Paxillus, the distinction between that genus and the genus Boletus is very slight indeed, consisting in this case merely in the eccentric or lateral stem.

The stem in *P. porosus* is most often lateral, and at the point of its insertion there is generally an excavation in the margin of the pileus which gives to it a somewhat reniform outline. The pileus has been described as "viscid when moist," but I have never observed this character in our plant. The color of the hymenium in the fresh plant is a bright chrome-yellow. The fresh plant sometimes emits a disagreeable, dirt-like odor.

Paxillus strigosus Pk. does not have the lamellæ branched or crisped at the base, and it has been omitted. It probably belongs rather to Inocybe.

NEW YORK SPECIES OF CANTHARELLUS.

CANTHARELLUS *Adans.*

"Hymenophorum continuous with the stem, descending unchanged into the trama. Lamellæ thick, fleshy or waxy, *fold-like*, sub-branched, *obtuse on the edge.* Spores white. *Fleshy or membranous putrescent fungi destitute of a veil.*" *Hymen. Europ.*, p. 455.

The prominent distinguishing characters of this genus are the fleshy substance of the plants and the obtuse edge of the lamellæ. In nearly all the species these are either dichotomously branched or reticulately or anastomosingly connected with each other. They are so narrow and thick in some species that they appear more like folds or veins than like lamellæ. When a transverse section of the lamellæ is made their fold-like character becomes apparent. The hymenial substance covers the entire lower surface of the pileus and hence the interspaces are fertile as well as the lamellæ. Although some species formerly included in this genus are now excluded, it still contains some incongruous members. Thus *C. floccosus* bears very little general resemblance to *C. infundibuliformis*, and *C. aurantiacus* looks strangely by the side of *C. pruinosus.* It has, therefore, seemed best to group the species into subgenera or sections according to their natural affinities.

In the section AGARICOIDES the pileus is fleshy and is rapidly narrowed below into the stem. The lamellæ are very thin and close, resembling much those of the Agarici, but they are obtuse on the edge and regularly and sometimes repeatedly dichotomous. The species of this group are closely related to the Agarici.

In EUCANTHARELLUS the pileus is narrowly obconic and tapers downward gradually till it is lost in the short stem. Sometimes the spreading margin makes it trumpet-shaped. The lamellæ are very narrow, thick and abundantly and reticulately branched.

In CANTHARELLUS (proper) the pileus is fleshy, glabrous and more horizontally expanded, and the lamellæ are broader, more distant, and more sparingly branched than in the preceding group. The stem is also longer in proportion to the size of the pileus.

In LEPTOCANTHARELLUS the pileus is fleshy but thin, and floccose, fibrillose or pruinose. It is umbilicate, centrally depressed or funnel-shaped and sometimes pervious. The lamellæ are mostly sparingly branched, and the slender stem is generally hollow. The last three groups contain species which have their respective counterparts or corresponding species in the genus Craterellus.

In the diagnosis of the genus which I have quoted the spores are said to be white, but in some of our species they vary considerably from this color.

The name of the genus is derived from *cantharus*, a kind of drinking cup.

Synopsis of the Species.

1 Lamellæ thin, regularly and repeatedly dichotomous.	2.
2 Lamellæ orange-colored.	C. aurantiacus.
2 Lamellæ white.	C. umbonatus.
1 Lamellæ thick, simple or irregularly branched.	3.
3 Stem very short, hairy or subtomentose.	4.
4 Pileus floccose-scaly.	C. floccosus.
4 Pileus glabrous.	C. brevipes.
3 Stem longer, glabrous.	5.
5 Pileus glabrous, yellow.	6.
6 Pileus thick, stem solid.	C. cibarius.
6 Pileus thin, stem stuffed or hollow.	C. minor.
5 Pileus glabrous, cinnabar-red.	C. cinnabarinus.
5 Pileus not glabrous.	7.
7 Floccose or fibrillose.	8.
8 Dingy-yellow or brownish.	C. infundibuliformis.
8 Dingy-cinereous or blackish-cinereous.	C. cinereus.
7 Pruinose.	C. pruinosus.

AGARICOIDES. *Lamellæ thin, close, regularly dichotomous.*

Cantharellus aurantiacus *Wulf.*

Orange Chantarelle. False Chantarelle.

Pileus fleshy, thick, soft, minutely tomentose, plane or slightly depressed, *yellowish-orange*, often tinged with smoky-brown, the margin decurved or involute, flesh whitish or yellowish ; lamellæ narrow, close, repeatedly forked, decurrent, *bright-orange*, sometimes yellowish ; stem equal or slightly tapering upward, solid, subconcolorous ; spores subelliptical, .00025 to .0003 in. long, .00016 to .00018 broad.

Plant 2 to 3 in. high, pileus 1 to 3 in. broad, stem 2 to 5 lines thick.

Ground and much decayed wood. Common in hilly and mountainous districts. July to October.

The bright color and regular bifurcations of the lamellæ render this a beautiful and easily recognizable species. The pileus is somewhat obconic in outline, but it is subject to some variation in color. The disk is often tinged with brown or smoky-brown and sometimes the whole surface fades to a dingy buff-red. The margin is sometimes a pale yellow or even whitish, and a form with whitish lamellæ has occurred in a sphagnous marsh near Albany. In the European plant the stem is said occasionally to become black. This form is *Merulius nigripes* Pers. The wholly white European form has not been found here.

The species is pronounced "poisonous" by some authors, and "scarcely esculent" by Rev. M. J. Berkeley. It is especially fond of a damp mossy soil filled with vegetable mold, and it sometimes occurs quite late in the season.

Cantharellus umbonatus *Fr.*

Umbonate Chantarelle.

Pileus thin, soft, at first convex, then plane or centrally depressed, umbonate, papillate or even, smooth or flocculose-silky, rarely minutely squamulose, bluish-cinereous, grayish-brown or blackish-cinereous, the flesh white; lamellæ thin, straight, more or less decurrent, dichotomous, white; stem equal or slightly tapering upward, solid or stuffed, generally slightly silky, villose or white-tomentose at the base, whitish or tinged with the color of the pileus; spores white, oblong or subfusiform, .0004 to .0005 in. long, .00016 to .0002 broad.

Plant 1 to 6 in. high, pileus 6 to 12 lines broad, stem 2 to 4 lines thick.

Damp, mossy ground in woods and open places. North Elba, Catskill mountains and Karner. August to October.

Var. *subcæruleus.* Pileus bluish or bluish-gray, silky and shining.

Var. *dichotomus.* Pileus even or the umbo reduced to a mere papilla, grayish-brown.

Var. *brevior.* Pileus as in variety *dichotomus*, but the stem very short, about 1 inch long, equal and scarcely silky.

This is a variable species. All the descriptions of the European plant which have come under my notice speak of it as umbonate, and some emphasize this character and describe it as "always persistent," "unchanged," etc. In the American plant it is often entirely absent, and when present it is generally a mere acute papilla.

If of fair size in the fresh plant it becomes small and inconspicuous in the dried specimen. In consequence of this disagreement between the American plant and the descriptions of the European, the former was supposed to be distinct, and described in the Twenty-third Report as *Cantharellus dichotomus;* but from its close agreement in other respects I am now of the opinion that our plant is but a variety of the European, and I have modified the description of the species so that it may include our forms. I have looked in vain for a description of the spore characters of this species in any of the European works at my command. These characters here given are taken from the American plant. Should they be found to differ from those of the European plant, it will be necessary to keep our plant distinct. In ours, as in the European, wounds of the flesh and lamellæ often change to a reddish hue, and sometimes the lamellæ assume this color in drying. When growing among mosses the stem is often considerably elongated, and the white tomentum at its base so closely invests the surrounding mosses that it is difficult to pluck the plant entire without taking with it a tuft of moss.

EUCANTHARELLUS. *Lamellæ very narrow, thick, vein-like, abundantly branching or anastomosing; pileus narrowly obconic; stem very short.*

The species of this section appear thus far to be peculiar to America.

Cantharellus floccosus *Schw.*

Floccose Chantarelle.

Pileus fleshy, firm, *elongated funnel-form or trumpet shape, floccose-scaly, ochraceous-yellow;* lamellæ thick, narrow, close, abundantly anastomosing above, long-decurrent and subparallel below, *subconcolorous;* stem very short, thick, sometimes with a flexuous, root-like prolongation; spores ochraceous, narrowly elliptical, .0005 to .0006 in. long, .0003 in. broad, with an oblique apiculus at one end.

Plant 2 to 5 in. high, pileus 2 to 4 in. broad, stem 4 to 8 lines thick.

Woods and their borders. Common. July and August.

This is our largest species of Chantarelle. At first the plant is almost cylindrical, it being scarcely broader at the top than at the base; but it gradually expands above and spreads its margin until it becomes trumpet-shaped. The pileus of the young plant is some-

times tinged with orange. The scales are sometimes thick and persistent, and again thin and subevanescent. The pileus is depressed or umbilicate at a very early age, and it frequently becomes pervious when mature. The interstices or reticulations formed by the anastomosing of the lamellæ are in some specimens as broad as long, in others much longer than broad. The stem is often, though not always, somewhat tomentose.

Cantharellus brevipes *Pk.*

Short-stemmed Chantarelle.

Pileus fleshy, narrowly obconic, *glabrous, alutaceous or dingy cream color*, the thin margin erect, often irregular and lobed, tinged with lilac in the young plant, flesh soft, whitish ; lamellæ numerous, nearly straight on the margin, abundantly anastomosing below, *pale umber tinged with lilac ;* stem short, tomentose-pubescent, solid, cinereus, often tapering downwards ; spores yellowish, oblong-elliptical, uninucleate, .0004 to .0005 in. long, .0002 in. broad.

Plant subcæspitose, 3 to 4 in. high, pileus 2 to 3 in. broad, stem 4 to 6 lines thick.

Woods. Ballston. July.

This is a very rare species. It occurred in very limited quantity in 1879, in the locality mentioned, and has not since been found. It is smaller than *C. floccosus*, more cæspitose in its mode of growth, and with thinner lamellæ. The thick fleshy pileus is neither pervious nor umbilicate and but slightly depressed.

CANTHARELLUS. *Lamellæ narrow, distant, sparingly and irregularly branched or anastomosing ; pileus fleshy, glabrous ; stem fleshy, generally solid.*

Cantharellus cibarius *Fr.*

Edible Chantarelle.

Pileus fleshy, firm, convex, then expanded or slightly depressed, glabrous, *yellow*, the margin at first involute, then spreading, often wavy or irregular, flesh white within ; lamellæ narrow, thick, distant, decurrent, somewhat branched or anastomosing, yellow ; stem firm, glabrous, *solid*, *yellow*, sometimes tapering downwards ; spores subelliptical, .0003 to .0004 in. long, .0002 to .00025 broad.

Plant 1.5 to 4 in. high, pileus 1.5 to 4 in. broad, stem 3 to 6 lines thick.

Woods, copses and open places. Common. June to September.

The edible Chantarelle, though often irregular in shape, is beautiful in color. The whole plant is of a clear, rich egg-yellow hue, and this, with its solid stem, renders its identification easy. The American plant scarcely varies in color, but in Europe there is said to be a white variety of it. When old, the margin first begins to dry, and soon assumes a dull reddish-brown hue. The flesh both of the pileus and stem is white, though often tinged with yellow near the surface. Some authors attribute to it an odor like that of ripe apricots, but I have not been able to detect any decided odor in it. The lamellæ vary somewhat in their degree of proximity to each other and in the extent of their ramification. They are sometimes wavy or crisped as in some species of Paxillus. The interspaces are usually venose. The length of the stem is generally about equal to the breadth of the pileus. It is more frequently curved or flexuous than straight, and sometimes it is narrowed downward. The spores are described by most authors as white, but if they are collected on white paper they have a slight yellowish or salmon-yellow tint. The plant grows either in a scattered manner or arranged in curved lines, as if attempting to form a "fairy ring." A favorite habitat is in the deep shade of hemlock trees, but it also grows freely and plentifully in thin woods of deciduous trees in damp, showery weather. The species is quite celebrated for its edible qualities. Fries says that "it is justly enumerated among the most sapid fungi;" Badham, that "no fungus is more popular;" Berkeley, that "it is occasionally served up at public dinners at the principal hotels in London on state occasions, when every effort is made to secure the rarest and most costly dainties;" Cooke, that "it is alike esteemed in France, Germany, Austria and Italy," and that "it is not at all uncommon to hear from epicures rapturous encomiums of this golden fungus." According to Badham, "it requires to be gently stewed, and a long time, to make it tender; but by soaking it in milk the night before, less cooking will be requisite."

Cantharellus cinnabarinus *Schw.*

Cinnabar-colored Chantarelle.

Pileus fleshy, rather thin, firm, convex, then depressed or subinfundibuliform, often irregular, *cinnabar-red*, the margin at first inflexed, often lobed in large specimens, flesh whitish, externally tinged with red; lamellæ subdistant, branched, decurrent, *cinnabar-*

red; stem glabrous, solid, *cinnabar-red;* spores subelliptical, .0003 to .0004 in. long, .0002 to .00025 in. broad.

Plant 1 to 2 in. high, pileus 8 to 16 lines broad, stem 2 to 4 lines thick.

Thin woods and open places. Sandlake, Brewerton and Forestburgh. July to September.

This Chantarelle is beautifully colored, though frequently irregular in shape. It is closely related to the preceding species, from which its color, smaller size and comparatively broader lamellæ distinguish it. It varies slightly in the depth of its color, the pileus being sometimes tinged with yellow. It is difficult to preserve its red hue in the dried specimens. The width of the lamellæ is generally equal to or greater than the thickness of the flesh of the pileus. The flesh has a slightly pungent or peppery taste. The species was placed by Fries in the genus Hygrophorus, but it is a genuine Cantharellus.

Cantharellus minor *Pk.*

Small Chantarelle.

Pileus fleshy, thin, convex, then expanded, often umbilicate or centrally depressed, glabrous, *yellow*, flesh, pale-yellow; lamellæ narrow, distant, sparingly branched, yellow; stem *slender*, subflexuous, subequal, smooth, *stuffed or hollow*, yellow, with a whitish mycelium at the base; spores subelliptical, .00025 to .0003 in. long, .00016 to .0002 in. broad.

Plant gregarious or subcæspitose, 1 to 1.5 in. high, pileus 6 to 12 lines broad, stem 1 to 2 lines thick.

Thin woods and open places. Greenbush and Sandlake. June and July.

This is a very small Chantarelle. It is colored like *C. cibarius*, from which it is distinguished by its smaller size, thin and frequently umbilicate pileus, comparatively broader lamellæ, and more slender stem, and smaller spores. In very small or young specimens the stem sometimes appears to be solid, but in large and mature specimens it is stuffed or hollow, especially in the upper part. By this character it connects this section with the next. In wet weather the pileus is moist and has a watery-yellow hue which fades slightly in drying.

LEPTOCANTHARELLUS. *Pileus thin or submembranous, not glabrous; stem subelongated, generally hollow.*

Cantharellus infundibuliformis *Scop.*

Funnel-shaped Chantarelle.

Pileus thin or submembranous, convex and umbilicate, then funnel-shaped and often pervious, slightly floccose or fibrillose, uneven, varying in color from dingy-yellow to dark watery-brown when moist, grayish or grayish-yellow or grayish-brown when dry, the margin frequently wavy, irregular or lobed; lamellæ narrow, thick, decurrent, distant, irregularly or dichotomously branched, yellow or subcinereous, *becoming pruinose*, the interspaces generally venose; stem rather slender, glabrous, hollow, *yellow;* spores broadly elliptical, .00035 to .00045 in. long, .0003 to .00035 in. broad.

Var. *typicus.* Pileus dingy-yellow; stem pale-yellow.

Var. *luteolus.* (Cantharellus lutescens, 23d Rep., p. 122.) Pileus convex, umbilicate, dingy-yellow; lamellæ very distant, sparingly branched, yellowish; stem yellow, tinged with red or orange.

Var. *zonatus* Fr. Pileus zonate.

Var. *subcinereus.* Pileus dark watery-brown when moist, gray or grayish-brown when dry; stem yellowish, dingy above.

Plant gregarious or subcæspitose, 1.5 to 4 in. high, pileus 6 to 18 lines broad, stem 1.5 to 3 lines thick.

Woods and swamps among moss or fallen leaves and on decayed wood. Common. June to October.

This species is so variable that it seems desirable to designate its principal varieties by name. Through variety *subcinereus* it approaches *C. cinereus* on one hand, and, through variety *luteolus*, *C. tubæformis* on the other. Indeed, so closely is it allied to this last-named species that the two were united in Systema Mycologicum. But in all our forms or varieties the lamellæ become frosted or pruinose in appearance, and this character, according to the descriptions of Professor Fries, is a distinguishing feature of *C. infundibuliformis.* In the description of *C. tubæformis*, as given in the Handbook, the lamellæ of it also are said to be "frosted with a white bloom," but the dimensions there ascribed to its stem and spores do not correspond to those of any of our specimens. In our plant the pileus of fresh growing specimens has a moist or watery appearance, and as the moisture evaporates the color becomes paler. The surface of the pileus is a little uneven, and the fibrils are so arranged that they give it a somewhat streaked or virgate appearance approaching sometimes to a subreticulate aspect. Occasionally the pileus is slightly zonate,

but such specimens grow intermingled with others that are not zonate and are evidently the same species. In the larger specimens the pileus is frequently more lobed and irregular than in the others. In these also the lamellæ are apt to be less distant and more branched and the interspaces more venose than usual. The color of the lamellæ may be yellow, grayish-yellow, subcinereous or even tinged with lilac. The stem in variety *typicus* is pale-yellow or flavid, in variety *luteolus* it is more or less tinged with red, and in variety *subcinereus* it has a dingy or smoky tint above. This variety occurs especially among Sphagnum in marshes.

Cantharellus cinereus *Pers.*

Gray Chantarelle.

Pileus thin, submembranous, centrally depressed or funnel-shaped, often becoming pervious, minutely hairy or scaly, *cinereous* or *blackish-cinereous*, the margin frequently lobed or irregular; lamellæ thick, distant or subdistant, decurrent, branched and anastomosing, *cinereous;* stem hollow, often compressed or irregular, *cinereous or blackish-cinereous;* spores elliptical, .0003 to .00035 in. long, .0002 to .00025 broad.

Plant gregarious or cæspitose, 1.5 to 3 in. high, pileus 1 to 2 in. broad, stem 2 to 4 lines thick.

Woods. Greig, Sandlake and Albany. August and September.

The gray Chantarelle is less common than the preceding species to which it is closely related, but from which it may be distinguished by the absence of yellow hues from its pileus and stem. Its stem is generally comparatively thicker and its mode of growth more cæspitose.

Cantharellus pruinosus *Pk.*

Frosted Chantarelle.

Pileus thin, convex, subumbilicate, *pruinose, white;* lamellæ *rather broad*, distant, long-decurrent, *simple or rarely branched, white;* stem long, slender, slightly enlarged above, *pruinose*, whitish; spores *globose*, .0002 to .00025 in. in diameter.

Plant about 1 in. high, pileus 2 to 3 lines broad, stem scarcely 1 line thick.

Ground in pastures. Sageville. August.

This is our smallest species, and is one most readily recognized by its slender habit, white color and minutely mealy or pruinose surface.

In some respects it approaches the European *C. Brownii* B. & Br., but is clearly distinct from it, by its broad and very decurrent lamellæ, by its pruinose surface and by its umbilicate instead of an umbonate pileus.

Cantharellus crispus differs from all the preceding species in habit and texture and is now referred to the genus Trogia.

Satisfactory examples of *Cantharellus tubæformis* have not occurred within our limits. The specimens formerly referred to this species and to *C. lutescens* prove to be only forms of *C. infundibuliformis*.

Several dimidiate and resupinate species of this genus are found in Europe, but none have occurred within our limits.

NEW YORK SPECIES OF CRATERELLUS.

CRATERELLUS *Fr.*

"Hymenium waxy-membranous, distinct, but adnate to the hymenophorum, definitely inferior, continuous, glabrous, even or rugose. Spores white.

"*Terrestrial, fleshy or membranous, autumnal fungi, related to the Cantharelli and furnished with an entire pileus and a stem.*" *Hymen. Europ.*, p. 630.

This genus is intimately related to Cantharellus on one hand, and by its nearly even hymenium it approaches Thelephora and Clavaria on the other. So intimate is its relationship with Cantharellus that, in the Systema Mycologicum, its species were referred to that genus, and in his later work, the Hymenomycetes Europæi, Professor Fries justly remarks that the analogy between various species of the two genera is wonderful. Indeed, some of the species of these genera cannot readily be distinguished without an inspection of the hymenium, so closely do they resemble each other in size, shape and color. The species of Craterellus have the hymenium nearly even, or merely rugose or rugose-wrinkled, the folds or wrinkles being irregular or indistinct, or so interwoven and lost in each other and in the hymenium that any particular one cannot readily be traced from the stem to the margin of the pileus, as they can be in species of Cantharellus. In the same species the wrinkles are more distinct in some specimens than in others, and often they are more distinct in the fresh plant than in the dried one. In all our species the hymenium is decurrent. The pileus is frequently more or less split or lobed on the margin and sometimes is divided nearly to its base. It is not clear why the genus should be characterized as "autumnal," for some of the species occur as early as July. In some of the older works these fungi are distributed in the genera Cantharellus, Merulius, Elvella and Peziza. The name Craterellus signifies a little cup, and has reference to the shape of the pileus in some species.

Synopsis of the Species.

1 Stem hollow, pileus mostly pervious.	2.
2 Hymenium cinereous or brown.	3.
3 Pileus tubiform, spores .0005 to .0007 in. long.	C. cornucopioides.
3 Pileus funnel-shaped, spores .00025 to .0003 in. long.	C. dubius.
2 Hymenium yellow.	C. lutescens.
1 Stem solid, pileus not pervious.	4.
4 Hymenium and stem similarly colored.	C. Cantharellus.
4 Hymenium and stem dissimilarly colored.	C. clavatus.

Craterellus cornucopioides *Pers.*

Cornucopia-like Craterellus. Horn-like Craterellus.

Pileus thin, submembranous, *tubiform*, pervious, sometimes granular or minutely scaly, cinereous, smoky-brown or blackish, the spreading or decurved margin generally lobed, wavy or irregular; hymenium even or rugose-wrinkled, cinereous or brown; stem very short, hollow, *blackish-brown or black;* spores *narrowly elliptical*, .0005 to .0007 in. long, .0003 to .0004 broad.

Plant gregarious or subcæspitose, 2 to 3 in. high, pileus 1 to 2.5 in. broad, stem 2 to 3 lines thick.

Woods. Common. July to September.

This is our most common Craterellus. It is easily recognized by its elongated tubular or narrowly trumpet-shaped pileus and its dingy-gray or smoky-brown hue. The pileus is thin but rather tough and elastic. The hymenium is generally a little paler than the pileus and varies in color from cinereous to reddish-brown and dark smoky-brown. It sometimes becomes pruinose when dry. The stem is short or almost obsolete, the hymenium extending nearly or quite to the surface of the ground. The spores are larger than in any of our other species. It grows especially on naked soil on shaded banks or knolls or in old roads in woods. In shape it corresponds very closely to *Cantharellus floccosus*, but in every other respect it differs decidedly from that species. In color it resembles *Cantharellus cinereus*, from which its more elongated pileus, shorter stem and different hymenium at once separate it. *Cantharellus cornucopioides* Fr., *Peziza cornucopioides* L., *Merulius cornucopioides* Pers., *Merulius purpureus* With. and *Helvella cornucopioides* Scop. are ancient synonyms.

Craterellus dubius *Pk.*

Doubtful Craterellus.

Pileus thin, *infundibuliform or subtubiform*, subfibrillose, dark-brown or lurid-brown, pervious, the margin generally wavy and

lobed; hymenium dark-cinereous and rugose when moist, the obscure crowded irregular wrinkles abundantly anastomosing, nearly even and paler when dry; stem short, hollow, *colored like the hymenium;* spores *broadly elliptical or subglobose*, .00025 to .0003 in. long, .0002 to .00025 in. broad.

Plant single or cæspitose, 2 to 3 in. high, pileus 1 to 2 in. broad, stem about 2 lines thick.

Ground under spruce trees. Adirondack mountains. August.

This very rare species has not been found by us since its discovery in Keene Valley, Essex county, in 1877. It is closely related to *C. cornucopioides*, from which its shorter more funnel-shaped pileus, longer paler stem and smaller spores will distinguish it. It is also apparently similar to *C. sinuosus* and *C. crispus*, and both it and they may yet prove to be different forms of one very variable species. In all of our specimens the pileus is pervious and the stem hollow to the base. This last character will distinguish the species from both those mentioned. In some specimens the pileus is much lobed or multifid on the margin. The hymenium is darker colored and much more rugose or uneven when moist than it is when dry. In the dried specimens it is pale-cinereous, often with a tinge of yellow, and its color extends to the base of the stem. The darker color of the pileus is continued downwards in the cavity of the stem. In general appearance this species corresponds more closely to *Cantharellus cinereus* than does *C. cornucopioides*, which is sometimes compared with that species.

Craterellus lutescens *Fr.*

Yellowish Craterellus.

Pileus thin, submembranous, varying from convex and umbilicate to tubiform or funnel-shaped, often becoming pervious, *yellowish, dingy-yellow or brownish*, the margin frequently lobed, wavy or irregular; hymenium nearly even or distinctly and sometimes densely rugose-wrinkled, *yellow;* stem rather slender, subflexuous, glabrous, *hollow, yellow;* spores subelliptical, .0004 to .0005 in. long, .00025 to .0003 in. broad.

Plant single or gregarious, occasionally cæspitose, 2 to 3 in. high, pileus 1 to 2 in. broad, stem 1.5 to 3 lines thick.

Moist places in woods and swamps. Sandlake and Helderberg mountains. July and August.

This species corresponds closely in size, color and general appearance to *Cantharellus infundibuliformis*, from which it is not readily distinguished except by its hymenium, which is neither pruinose nor furnished with distinct lamellæ, though its vein-like wrinkles sometimes make a close approach to the narrow lamellæ of that Chantarelle. It is commonly compared with *Cantharellus tubæformis*, with which, according to Fries, it was formerly confused, and to which it corresponds very closely by reason of its naked yellow hymenium. The pileus of the European plant is described as "flocculose," but in our plant it is usually almost glabrous or but slightly fibrillose. The hymenium is sometimes slightly reddish or orange-tinted and the stem is colored like it rather than like the pileus. In small or young plants it is not uncommon to find the stem stuffed below and hollow above only. The base of the stem is frequently hairy or strigose.

Cantharellus lutescens Fr., *Merulius lutescens* Pers., *Merulius xanthopus* Pers., *Helvella tubæformis* Schæff. and *Peziza undulata* Bolt. are synonyms of the older works.

Craterellus Cantharellus *Schw.*

Chantarelle Craterellus.

Pileus fleshy, firm, *convex, then centrally depressed or infundibuliform*, glabrous, yellow or pinkish-yellow, the margin commonly lobed, wavy or irregular, flesh white; hymenium nearly even or rugose-wrinkled, *yellow;* stem glabrous, *solid*, *yellow;* spores subelliptical, .0003 to .0004 in. long, .0002 to .00025 in. broad.

Plant single or cæspitose, 1.5 to 3 in. high, pileus 1.5 to 3 in. broad, stem 3 to 5 lines thick.

Thin woods and bushy places. Sandlake. August.

So closely does this plant resemble the edible Chantarelle, both in size, shape and color, that it would be natural to suppose it a form of that species with an undeveloped or abnormally developed hymenium. Its color is a vitelline or egg-yellow, as in that species, but sometimes there is a slight pinkish tinge to the pileus and a faint shade of salmon color or orange to the hymenium. The spores also, when collected on white paper, have a yellowish or salmon-yellow tint. The plant is more frequently cæspitose than *Cantharellus cibarius*, and consequently the pileus is generally more irregular. It was placed by Schweinitz in the genus Thelephora, section CRATERELLÆ, whence the synonym *Thelephora Cantharellus* Schw. In Grevillea, vol. 1, p. 147, this name is given as a synonym of *Craterellus late-*

ritius B., which is described as "brick-red" with a deeply umbilicate pileus. I have seen no such forms of our plant and hesitate to adopt the opinion there expressed. The species appears to be peculiar to this country.

Craterellus clavatus *Pers.*

Pileus fleshy, soft, *clavate or narrowly obconic*, turbinate, truncate or slightly depressed, nearly glabrous, yellowish, flesh white ; hymenium slightly corrugated or rugose-wrinkled, *dull-purplish or brownish incarnate ;* stem short, solid, pallid or yellowish ; spores subelliptical, .0004 to .0005 in. long, .0002 to .0003 in. broad.

Plant 2 to 3 in. high, pileus 1 to 2 in. broad, stem 3 to 6 lines thick.

Hemlock woods. Brewerton. September. Rare.

This species has not been found by me since its discovery in our State in 1878. Its corresponding species among the Chantarelles is *Cantharellus brevipes.* Its resemblance to *Clavaria pistillaris* is also noticeable. The pileus is sometimes slightly uneven or rugose, and its margin is rather obtuse and sometimes crenately irregular. The color of the hymenium is a peculiar mixture of pink, brown, lilac and purple, which is not easy to define. It sometimes approaches a pale-liver color. Fries describes it as passing from violet-flesh color to fuliginous and umber-brown. These variations in the color of the hymenium have given rise to various synonyms ; for example, *Merulius violaceus* Pers., *Merulius purpurascens* Pers., *Merulius carneus* Pers., and *Merulius umbrinus* Pers. Other synonyms are *Merulius clavatus* Pers., *Clavaria truncata* Schmidt, and *Clavaria elvelloides* Wulf.

Craterellus cæspitosus Pk. is a spurious species and is therefore omitted.

NAMES OF NEW YORK PYRENOMYCETOUS FUNGI.

The names by which the following species were formerly known or reported are given in the right-hand column whenever they differ from those of the Saccardoan system. The left-hand column contains the names required by that system.

Perisporiaceæ.

Podosphæra tridactyla *De By.*	Podosphæra Kunzei *Lev.*
P. biuncinata *C. & P.*	
Sphærotheca Castagnei *Lev.*	
S. pruinosa *C. & P.*	
Phyllactinia suffulta *Sacc.*	Phyllactinia guttata *Lev.*
Uncinula adunca *Lev.*	
U. Ampelopsidis *Pk.*	
U. Clintonii *Pk.*	
U. macrospora *Pk.*	
U. flexuosa *Pk.*	
U. geniculata *Ger.*	
U. circinata *C. & P.*	
U. parvula *C. & P.*	
U. luculenta *Howe.*	
U. Americana *Howe.*	Uncinula spiralis *B. & C*
Microsphæra Astragali *Trev.*	Microsphæra holosericea *Lev.*
M. abbreviata *Pk.*	
M. Hedwigii *Lev.*	
M. Dubyi *Lev.*	
M. Friesii *Lev.*	
M. penicillata *Lev.*	
M. Van Bruntiana *Ger.*	
M. densissima *Schw.*	
M. Russellii *Clinton.*	
M. extensa *C. & P.*	
M. diffusa *C. &. P.*	
M. pulchra *C. & P.*	
M. Vaccinii *C. & P.*	
M. Platani *Howe.*	
M. Menispermi *Howe.*	
M. Symphoricarpi *Howe.*	
Erysiphe communis *Fr.*	
E. Martii *Lev.*	
E. lamprocarpa *Lev.*	
E. Liriodendri *Schw.*	
E. Euphorbiæ *Pk.*	
Erysiphella aggregata *Pk.*	
Eurotium herbariorum *Lk.*	
Dimerosporium Collinsii *Thum.*	Sphæria Collinsii *Schw.*
Scorias spongiosa *Fr.*	

Sphæriaceæ.

Cœlosphæria exilis *Sacc.*	Sphæria exilis *A. & S.*
Fracchiæa callista *B. & C.*	S. callista *B. & C.*
Calosphæria Princeps *Sel.*	Valsa pulchella *Fr.*
Coronophora oötheca *Sacc.*	Sphæria oötheca *B. & C.*
Quaternaria Persoonii *Tul.*	Valsa quaternata *Fr.*
Valsa Pini *Fr.*	
V. Vitis *Fckl.*	
V. Alni *Pk.*	
V. Linderæ *Pk.*	
V. subclypeata *C. & P.*	
V. Americana *B. & C.*	
V. truncata *C. & P.*	
V. centripeta *Fr.*	
V. colliculus *Wormsk.*	
V. Rubi *Fckl.*	
V. nivea *Fr.*	
V. leucostoma *Fr.*	
V. ambiens *Fr.*	
V. salicina *Fr.*	
V. translucens *De Not.*	
Eutypella Prunastri *Sacc.*	Valsa Prunastri *Fr.*
E. stellulata *Sacc.*	V. stellulata *Fr.*
E. Platani *Sacc.*	V. Platani *Schw.*
E. fraxinicola *Sacc.*	V. fraxinicola *C. & P.*
E. tumidula *Sacc.*	V. tumidula *C. & P.*
E. innumerabilis *Sacc.*	V. innumerabilis *Pk.*
Eutypa Acharii *Tul.*	
E. lata *Tul.*	
E. spinosa *Tul.*	Sphæria limæformis *Schw.*
Diatrype disciformis *Fr.*	
D. Stigma *Fr.*	
D. platystoma *Berk.*	
D. bullata *Fr.*	
D. corniculata *B. & Br.*	
D. asterostoma *B. & C.*	
D. Duriæi *Mont.*	
Diatrypella Tocciæana *De Not.*	Diatrype Tocciæana *De Not.*
D. aspera *Nits.*	D. aspera *Fr.*
D. discoidea *C. & P.*	D. discoidea *C. & P.*
D. betulina *Pk.*	D. betulina *Pk.*
D. Cephalanthi *Sacc.*	D. Cephalanthi *Schw.*
D. prominens *Howe.*	
Ceratostoma rubefaciens *Sacc.*	Sphæria rubefaciens *Pk.*
C. piliferum *Fckl.*	S. piliferum *Fr.*
Chætomium lanosum *Pk.*	
C. funicolum *Cke.*	
C. melioloides *C. & P.*	
C. comatum *Fr.*	Chætomium elatum *Kze.*
Sordaria coprophila *C. & D.*	Hypoxylon coprophilum *Fr.*
S. fimiseda *C. & D.*	Sphæria fimiseda *C. & D.*
S. amphicornis *Ellis.*	S. eximia *Pk.*

Sordaria valsoides *Sacc.*	Sphæria valsoides *Pk.*
Hypocopra leucoplaca *Sacc.*	S. leucoplaca *B. & R.*
Coprolepa fimeti *Sacc.*	S. fimeti *Pers.*
Philocopra canina *Sacc.*	S. canina *Pk.*
Rosellinia aquila *De Not.*	S. aquila *Fr.*
R. Desmazierii *Sacc.*	S. Desmazierii *B. & Br.*
R. mutans *Sacc.*	S. mutans *C. & P.*
R. obtusissima *Sacc.*	S. obtusissima *B. & C.*
R. pulveracea *Fckl.*	S. pulveracea *Ehrh.*
R. sordaria *Rehm.*	S. sordaria *Fr.*
R. hirtissima *Sacc.*	S. hirtissima *Pk.*
Bombardia fasciculata *Fr.*	S. bombarda *Batsch.*
Anthostomella Closterium *Sacc.*	S. Closterium *B. & C.*
A. rostrispora *Sacc.*	S. rostraspora *Ger.*
A. smilacinina *Sacc.*	S. smilacinina *Pk.*
Anthostoma adustum *Sacc.*	Diatrype adusta *C. & P.*
A. cercidicolum *Sacc.*	D. cercidicola *B. & C.*
A. atropunctatum *Sacc.*	D. atropunctata *Schw.*
A.? scoriadeum *Sacc.*	Sphæria scoriadea *Fr.*
Xylaria polymorpha *Grev.*	
X. corniformis *Fr.*	
X. grandis *Pk.*	
X. acuta *Pk.*	
X. Hypoxylon *Grev.*	
X. digitata *Grev.*	
X. graminicola *Ger.*	
X. filiformis *Fr.*	
Ustulina vulgaris *Tul.*	Hypoxylon ustulatum *Bull.*
Daldinia concentrica *C. & D.*	H. concentricum *Bolt.*
Hypoxylon coccineum *Bull.*	H. fragiforme *Pers.*
H. argillaceum *Berk.*	
H. Howeanum *Pk.*	
H. fuscum *Fr.*	
H. xanthocreas *B. & C.*	
H. cohærens *Fr.*	
H. perforatum *Schw.*	
H. multiforme *Fr.*	
H. Morsei *B. & C.*	
H. serpens *Fr.*	
H. Sassafras *Berk.*	
H. atropurpureum *Fr.*	
H. rubiginosum *Fr.*	
H. fuscopurpureum *Berk.*	
H. smilacicolum *Sacc.*	Diatrype smilacicola *Schw.*
Nummularia discreta *Tul.*	D. discreta *Schw.*
N. Bulliardi *Tul.*	Hypoxylon nummularia *Bull.*
Ceratostomella rostrata *Sacc.*	Sphæria rostrata *Fr.*
Gnomoniella tubiformis *Sacc.*	S. tubæformis *Tode.*
G. mirabilis *Sacc.*	S. mirabilis *Pk.*
G. vulgaris *Sacc.*	S. Gnomon *Tode.*
G. curvicolla *Sacc.*	S. curvicolla *Pk.*
G. eccentrica *Sacc.*	S. eccentrica *C. & P.*

Gnomoniella fimbriata *Sacc.*	Sphæria fimbriata *Pers.*
G. Coryli *Sacc.*	S. Coryli *Batsch.*
G. melanostyla *Sacc.*	S. melanostyla *Fr.*
Læstadia carpinea *Sacc.*	Sphærella carpinea *Fr.*
L. fraxinicola *Sacc.*	Depazea fraxinicola *Curt.*
L. brunnea *Sacc.*	D. brunnea *B. & C.*
Physalospora minutella *Sacc.*	Sphæria minutella *Pk.*
P. ceanothina *Sacc.*	S. ceanothina *Pk.*
Trichosphæria fissurarum *Sacc.*	S. fissurarum *B. & C.*
T. subcorticalis *Sacc.*	S. subcorticalis *Pk.*
Wallrothiella Arceuthobii *Sacc.*	S. Arceuthobii *Pk.*
W. squalidula *Sacc.*	S. squalidula *C. & P.*
Botryosphæria Quercuum *Sacc.*	Melogramma Quercuum *Fr.*
Cryptosporella leptasca *Sacc.*	Valsa leptasca *P. & C.*
C. anomala *Sacc.*	Diatrype anomala *Pk.*
Sphærella punctiformis *Rabh.*	Sphæria punctiformis *Pers.*
S. maculiformis *Auersw.*	
S. spleniata *C. & P.*	
S. orbicularis *Pk.*	
S. colorata *Pk.*	
S. indistincta *Pk.*	
S. Impatientis *P. & C.*	
S. Vaccinii *Cke.*	
S. sparsa *Auersw.*	
S. Sarraceniæ *Sacc.*	S. Sarraceniæ *Schw.*
S. smilacicola *Cke.*	Depazea smilacicola *Schw.*
Stigmatea Robertiana *Fr.*	Dothidea Robertiana *Fr.*
Didymella Sphærellula *Sacc.*	Sphæria Sphærellula *Pk.*
D. onosmodina *Sacc.*	S. onosmodina *P. & C.*
Melanopsamma recessa *Sacc.*	S. recessa *C. & P.*
M. Papilla *Sacc.*	S. Papilla *Schw.*
Bertia moriformis *De Not.*	S. moriformis *Tode.*
Venturia ditricha *Karst.*	
V. Clintonii *Pk.*	
V. compacta *Pk.*	
V. Kalmiæ *Pk.*	
V. orbicula *C. & P.*	
V. pulchella *C. & P.*	
V. Dickiei *C. & D.*	
V. Myrtilli *Cke.*	
Endothia gyrosa *Fckl.*	S. gyrosa *Schw.*
Melanconis stilbostoma *Tul.*	Valsa stilbostoma *Fr.*
M. thelebola *Sacc.*	V. thelebola *Fr.*
Diaporthe platasca *Sacc.*	Diatrype platasca *Pk.*
D. acerina *Sacc.*	Valsa acerina *Pk.*
D. Woolworthii *Sacc.*	V. Woolworthii *Pk.*
D. leiphæma *Sacc.*	V. leiphæma *Fr.*
D. impulsa *Sacc.*	V. impulsa *C. & P.*
D. Cratægi *Fckl.*	V. Cratægi *Curr.*
D. bicincta *Sacc.*	V. bicincta *C. & P.*
D. oxyspora *Sacc.*	V. oxyspora *Pk.*
D. obscura *Sacc.*	V. obscura *Pk.*

Diaporthe mucronata *Sacc.*	Valsa mucronata *Pk.*
D. salicella *Sacc.*	Sphæria salicella *Fr.*
D. spiculosa *Nitsch.*	S. spiculosa *Pers.*
D. aculeata *Sacc.*	S. aculeata *Schw.*
D. racemula *Sacc.*	S. racemula *C. & P.*
D. Desmodii *Sacc.*	S. Desmodii *Pk.*
D. exercitalis *Sacc.*	S. exercitalis *Pk.*
D. picea *Sacc.*	S. picea *Pers.*
Didymosphæria Parnassiæ *Sacc.*	S. Parnassiæ *Pk.*
Massariella bufonia *Speg.*	Massaria bufonia *Tul.*
Parodiella perisporioides *Speg.*	Sphæria perisporioides *B. & C.*
Amphisphæria phileura *Sacc.*	S. phileura *C. & P.*
A. salebrosa *Sacc.*	S. salebrosa *C. & P.*
A. thujina *Sacc.*	S. thujina *Pk.*
Otthia alnea *Sacc.*	Cucurbitaria alnea *Pk.*
O. seriata *Sacc.*	C. seriata *Pk.*
Valsaria Peckii *Sacc.*	Valsa Peckii *Howe.*
V. moroides *Sacc.*	Diatrype moroides *C. & P.*
Massaria Corni *Sacc.*	Massaria gigaspora *Desm.*
M. Argus *Tul.*	
M. vomitoria *B. & C.*	
Leptosphæria Doliolum *De Not.*	Sphæria Doliolum *Pers.*
L. subconica *Sacc.*	S. subconica *C. & P.*
L. viridella *Sacc.*	S. viridella *Pk.*
L. ramulicola *Sacc.*	S. ramulicola *Pk.*
L. scapophila *Sacc.*	S. scapophila *Pk.*
L. sorghophila *Sacc.*	S. sorghophila *Pk.*
L. orthogramma *Sacc.*	S. orthogramma *B. & C.*
L. culmifraga *C. & D.*	S. culmifraga *Desm.*
L. Crepini *De Not.*	S. Crepini *West.*
L. Marcyensis *Sacc.*	S. Marciensis *Pk.*
L. taxicola *Sacc.*	S. taxicola *Pk.*
L. platanicola *Sacc.*	S. platanicola *Howe.*
Clypeosphæria Hendersoniæ *Sacc.*	S. Hendersoniæ *Ellis.*
Chætosphæria leonina *Sacc.*	S. leonina *C. & P.*
C. phæostromoides *Sacc.*	S. phæostromoides *Pk.*
Melanomma pulvis-pyrius *Fckl.*	S. pulvis-pyrius *Pers.*
Trematosphæria pertusa *Fckl.*	S. pertusa *Pers.*
Sporormia minima *Auersw.*	S. minima *Auersw.*
Aglaospora profusa *Lamb.*	Valsa profusa *Fr.*
Pseudovalsa bicornis *Sacc.*	Melanconis bicornis *Cke.*
P. lancif. v. elliptica *Pk.*	M. elliptica *Pk.*
P. sambucina *Sacc.*	Valsa sambucina *Pk.*
P. hapalocystis *Sacc.*	V. hapalocystis *B. & Br.*
Melogramma vagans *De Not.*	Melogramma Bulliardi *Tul.*
Metasphæria Semen *Sacc.*	Sphæria Semen *C. & P.*
M. staphylina *Sacc.*	S. staphylina *Pk.*
Lasiosphæria hirsuta *C. & D.*	S. hirsuta *Fr.*
L. cæsariata *Sacc.*	S. cæsariata *C. & P.*
L. viridicoma *Sacc.*	S. viridicoma *C. & P.*
L. canescens *Karst.*	S. canescens *Pers.*
L. xestothele *Sacc.*	S. xestothele *B. & C.*

Lasiosphæria Pezizula *Sacc.*	Sphæria Pezizula *B. & C.*
L. spermoides *C. & D.*	S. spermoides *Hoffm.*
L. ovina *C. & D.*	S. ovina *Pers.*
Acanthostigma Clintonii *Sacc.*	S. Clintonii *Pk.*
Zignoella exigua *Sacc.*	S. exigua *C. & P.*
Pleospora herbarum *Rabh.*	S. herbarum *Pers.*
Pyrenophora phæocomes *Sacc.*	
Iulella monosperma *Sacc.*	S. monosperma *Pk.*
Teichospora obducens *Fckl.*	S. obducens *Fr.*
T. interstitialis *Sacc.*	S. interstitialis *C. & P.*
T. phellogena *Sacc.*	S. phellogena *B. & C.*
Cucurbitaria elongata *Grev.*	S. elongata *Fr.*
C. Berberidis *Gray.*	
Thyridium Spraguei *Sacc.*	S. Spraguei *B. & C.*
Fenestella superficialis *Sacc.*	Melogramma superficialis *P. & C.*
F. Xanthoxyli *Sacc.*	Valsa Xanthoxyli *Pk.*
Ophiobolus fulgidus *Sacc.*	Sphæria fulgida *C. & P.*
O. porphyrogonus *Sacc.*	S. rubella *Pers.*
O. acuminatus *Duby.*	S. acuminata *Sow.*
O. Urticæ *Sacc.*	S. Urticæ *Rabh.*
Sillia ferruginea *Karst.*	Diatrype ferruginea *Fr.*
Cryptospora suffusa *Tul.*	Valsa suffusa *Fr.*
C. femoralis *Sacc.*	V. femoralis *Pk.*
C. cinctula *Sacc.*	V. cinctula *C. & P.*
C. trichospora *Sacc.*	V. trichospora *C. & P.*

Hypocreaceæ.

Nectriella mycetophila *Sacc.*	Nectria mycetophila *Pk.*
Melanospora lagenaria *Fckl.*	Sphæria lagenaria *Pers.*
Hypomyces lateritius *Tul.*	Hypocrea lateritia *Fr.*
H. Lactifluorum *Tul.*	H. Lactifluorum *Schw.*
H. floccosus *Fr.*	H. floccosa *Fr.*
H. ochraceus *Tul.*	
H. aurantius *Fckl.*	
H. Van Bruntianus *Ger.*	
H. polyporinus *Pk.*	
H. transformans *Pk.*	
Hypocrea rufa *Fr.*	
H. Patella *C. & P.*	
H. chromosperma *C. & P.*	
H. gelatinosa *Fr.*	
H. contorta *Schw.*	
H. Richardsoni *B. & M.*	
H. citrina *Fr.*	
H. alutacea *C. & D.*	
H. apiculata *C. & P.*	
Nectria Ribis *Rabh.*	
N. cinnabarina *Fr.*	
N. Celastri *Schw.*	
N. cucurbitula *Fr.*	
N. sanguinea *Fr.*	

Nectria episphæria *Fr.*	
N. Peziza *Fr.*	
N. Apocyni *Pk.*	
Gibberella pulicaris *Sacc.*	Sphæria pulicaris *Pers.*
G. Saubinetii *Sacc.*	S. Saubinetii *Mont.*
Claviceps purpurea *Tul.*	Cordyceps purpurea *Tul.*
Cordyceps pistillariæformis *B. & Br.*	Torrubia clavulata *Schw.*
C. superficialis *Sacc.*	T. superficialis *Pk.*
C. ophioglossoides *Tul.*	T. ophioglossoides *Tul.*
C. capitata *Lk.*	T. capitata *Fr.*
C. entomorrhiza *Fr.*	T. entomorrhiza *Fr.*
C. militaris *Lk.*	
Epichloe typhina *Tul.*	
Hypocrella Hypoxylon *Sacc.*	Epichloe Hypoxylon *Pk.*

Dothideaceæ.

Phyllachora Ulmi *Fckl.*	Sphæria ulmea *Schw.*
P. Lespedezæ *Sacc.*	S. Lespedezæ *Schw.*
P. graminis *Fckl.*	S. graminis *Pers.*
P. Caricis *Sacc.*	Dothidea Caricis *Fr.*
P. Trifolii *Fckl.*	D. Trifolii *Fr.*
P. flabella *Thum.*	D. flabella *B. & C.*
P. Pteridis *Fckl.*	D. Pteridis *Pers.*
P. Dalibardæ *Sacc.*	D. Dalibardæ *Pk.*
P. episphæria *Sacc.*	D. episphæria *Pk.*
Dothidiella Kalmiæ *Sacc.*	D. Kalmiæ *Pk.*
D. Osmundæ *Sacc.*	D. Osmundæ *P. & C.*
Plowrightia ribesia *Sacc.*	D. ribesia *Pers.*
P. morbosa *Sacc.*	Sphæria morbosa *Schw.*
Dothidea Sambuci *Fr.*	
D. tetraspora *B. & Br.*	
D. Linderæ *Ger.*	
Ropographus filicinus *Fckl.*	Dothidea filicina *Fr.*
R. clavisporus *Sacc.*	Hysterium clavisporum *C. & P.*

Microthyriaceæ.

Myiocopron Smilacis *Sacc.*	Microthyrium Smilacis *De Not.*

Lophiostomaceæ.

Lophiotrema Spiræeæ *Sacc.*	Lophiostomum Spiræeæ *Pk.*
L. Scrophulariæ *Sacc.*	L. Scrophulariæ *Pk.*
L. sexnucleatum *Sacc.*	L. sexnucleata *Cke.*
Lophiostoma triseptatum *Pk.*	
L. prominens *Pk.*	
L. turritum *C. & P.*	
L. magnatum *C. & P.*	
L. macrostomum *De Not.*	
L. scelestum *Sacc.*	
Lophidium obtectum *Sacc.*	L. obtectum *Pk.*

Hysteriaceæ.

Aulographum subconfluens *Pk.*	
Glonium stellatum *Muhl.*	
G. parvulum *Ger.*	
G. simulans *Ger.*	
G. hyalospermum *Ger.*	
G. lineare *De Not.*	Hysterium lineare *Fr.*
Angelina rufescens *Duby.*	Ascobolus conglomeratus *Schw.*
Hysterium pulicare *Pers.*	
H. angustatum *A. & S.*	
H. truncatulum *C. & P.*	
H. ellipticum *Fr.*	
H. macrosporum *Pk.*	
H. Thuiarum *C. & P.*	
H. magnosporum *Ger.*	
H. Azaleæ *Schw.*	
H. rimincolum *Schw.*	Dothidea rimincola *Schw.*
Mytilidion tortile *Sacc.*	Hysterium tortile *Schw.*
Dichæna faginea *Fr.*	
Gloniopsis australis *Sacc.*	H. australis *Duby.*
Hysterographium Fraxini *De Not.*	H. Fraxini *Pers.*
H. insidens *Sacc.*	H. insidens *Schw.*
H. Rousselii *Sacc.*	H. Rousselii *De Not.*
H. variabile *Sacc.*	H. variabile *C. & P.*
H. vulvatum *Rehm.*	H. vulvatum *Schw.*
Hypoderma ilicinum *De Not.*	H. ilicinum *De Not.*
H. nervisequum *DC.*	
H. Desmazieri *Duby.*	
H. lineare *Pk.*	Rhytisma lineare *Pk.*
H. virgultorum *DC.*	
H. commune *Duby.*	Hysterium commune *Fr.*
H. scirpinum *DC.*	H. scirpinum *Fr.*
H. Smilacis *Rehm.*	H. Smilacis *Schw.*
Lophodermium exaridum *C. & P.*	
L. maculare *De Not.*	H. maculare *Fr.*
L. hysterioides *Sacc.*	H. xylomoides *Chev.*
L. sphærioides *Duby.*	H. sphærioides *A. & S.*
L. Pinastri *Chev.*	H. Pinastri *Schrad.*
L. typhinum *Lamb.*	H. typhinum *Fr.*
Lophium mytilinum *Fr.*	
Colpoma morbidum *Sacc.*	Triblidium morbidum *Pk.*
C. lacteum *Pk.*	
Acrospermum compressum *Tode.*	

NEW YORK SPECIES OF VISCID BOLETI.

BOLETUS *Dill.*

Hymenium composed of separable tubes crowded into a porous stratum, without a trama, distinct and easily separable from the hymenophore. Mouths of the tubes either porous, round or angular; spores normally fusiform, rarely oval or subrotund. *Terrestrial, fleshy, putrescent, centrally stipitate fungi. Many of them valuable for their edible qualities, a few poisonous. Hym. Europ.*, p. 495.

This genus is related to Paxillus on one hand and to Polyporus on the other. It is more accurately limited than many others, but its species are numerous and less clearly defined. Some are very variable, others are too closely allied to be readily distinguished. Fries remarks that "no genus has given me more trouble than that of the Boleti." The difficulty is apparently due to the imperfect descriptions given by some authors and to the variability of some species whose limits have not been well ascertained.

Most of the Boleti grow in the warmest part of the season, and especially in very warm showery weather. They are scarce in dry weather. Some species attain a very large size, others exhibit a singular change of color in their tubes or flesh when cut or bruised. They are described as terrestrial, yet a few species sometimes occur also on much decayed wood.

The spores vary in color in different species, but this variation occurs in closely related species, so that it is not deemed available for classifying in series as in the genus Agaricus. It is, however, valuable as a specific character and should always be noted. Fries has taken the primary color of the tubes as the distinguishing character of the series, but the same objection holds in this case as in the other.

New York is rich in species of this genus. Two sections, LACERIPEDES Pk. (Torr. Bull. 1883, p. 73) and HIRTIPELLES Pk. (in. ed.) are represented, of which no examples appear to have occurred in Europe. We attempt here an exposition of the species of the Viscipelles, the first section in the Friesian arrangement.

VISCIPELLES. *Pileus covered with a viscose pellicle.* Stem solid, neither bulbous nor reticulated with veins. Tubes adnate to the stem, rarely sinuate, of one color. *Hym. Europ.*, p. 496.

In this section the species have the pileus either viscid or glutinous when moist, and in most of them the viscid pellicle is separable from the flesh. The flesh, when cut or exposed to the air does not, with one exception, assume the bluish tints so often seen in some of the members of other sections, yet in some, dull-pinkish or more obscure tints appear. In mature plants it generally becomes soft, almost floccose or cottony in texture. The tubes are mostly adnate or even slightly decurrent. In rare instances they may be somewhat depressed around the stem. The pores are usually of medium or large size and frequently angular. The dissepiments are often uneven or dentate. The mouths are colored like the rest of the tubes. Yellow or ochraceous hues prevail, but the tubes when young are paler than when mature. The stem is not distinctly bulbous, is always solid and generally glabrous or merely dotted. It is annulate in some, naked in others. In several closely related central species of the group it, as well as the tubes, exudes, when young, drops of a thick, gummy fluid, which soon hardens, becomes darker and forms sugary granules or glandular dots. The color of the spores is by no means uniform, but it is some shade of ochraceous, ferruginous or brown. The first and last species here described are exceptional by their slight viscidity. The first is also exceptional by its universal tomentose-pulverulent veil. Several species are edible. Nearly all occur in regions inhabited by pine or other coniferous trees, and are wanting in localities destitute of these trees.

Synopsis of the Species.

Stem annulate.	1.
Stem not annulate.	6.
1 Cuticle of the pileus red.	2.
1 Cuticle of the pileus not red.	3.
2 Pileus either wholly or on the margin yellow-pulverulent.	B. Ravenelii.
2 Pileus squamose.	B. spectabilis.
3 Young tubes whitish.	B. Elbensis.
3 Young tubes yellow.	4.
4 Stem not dotted.	B. Clintonianus.
4 Stem dotted.	5.
5 Stem 5 lines or more thick, annulus not glutinous.	B. luteus.
5 Stem less than 5 lines thick, annulus glutinous.	B. subluteus.
6 Stem dotted.	7.
6 Stem not dotted.	9.

7 Pileus yellow.	8.
7 Pileus not clear yellow.	B. granulatus.
8 Stem rhubarb color.	B. punctipes.
8 Stem yellow, 4 lines or more thick.	B. subaureus.
8 Stem generally yellow, less than 4 lines thick.	B. Americanus.
9 Pileus bay-brown or chestnut color.	10.
9 Pileus some other color.	B. piperatus.
10 Pileus very glutinous, stem very short.	B. brevipes.
10 Pileus merely viscid when moist, stem longer.	B. badius.

Boletus Ravenelii *B. & C.*

Ravenel's Boletus.

Pileus convex or nearly plane, slightly viscid when young or moist, at first *covered with a sulphur-yellow pulverulent tomentum*, the disk at length naked, dull-red, flesh whitish, sometimes with yellowish strains; tubes at first plane, adnate, pale-yellow, at length yellowish-brown or umber, sometimes becoming convex and slightly depressed around the stem, dingy-greenish when bruised, medium size, subrotund; stem nearly equal, *clothed and colored like the young pileus*, yellow within, with a slight somewhat evanescent tomentose annulus; spores ochraceous-brown, .0004 to .0005 in. long, .0002 to .00025 broad.

Plant solitary, rarely cæspitose, pileus 1 to 3 in. broad, stem 1.5 to 4 in. long, 3 to 6 lines thick.

Woods and copses. Rensselaer, Saratoga and Fulton counties.

This is a very distinct and beautiful species. Mr. Ravenel remarks in his notes that "this plant is not infested by larvæ, and preserves more constant characters than any other Boletus with which I am acquainted." The webby powdered filaments constitute a universal veil, which at first covers the whole plant and conceals the young tubes. As the pileus expands, the veil generally disappears from the disk and ruptures between the margin and the stem, a part adhering to each. In consequence of the peculiar veil and the slight viscidity of the pileus the species does not harmonize well with the associated species, and but for the slight annulus it might as well be placed near *B. piperatus.* The annulus is sometimes stained by the spores. These, when caught on white paper, at first appear to have a slight greenish tint.

Boletus spectabilis *Pk.*

Showy Boletus.

Pileus broadly convex, at first *covered with a red tomentum*, then *squamose*, viscid when moist, *red*, the tomentose scales becoming grayish-red, brownish or yellowish, flesh whitish or pale-yellow; tubes

at first yellow, concealed by a reddish glutinous membrane, then ochraceous, convex, *large*, *angular*, adnate; stem nearly equal, annulate, yellow above the annulus, red or red with yellow stains below; spores *purplish-brown*, .0005 to .0006 in. long, .00025 to .00028 broad.

Pileus 2 to 5 in. broad, stem 3 to 5 in. long, 4 to 6 lines thick.

Thin woods in swamps. Adirondack mountains. August.

This rare and showy species is at present known only from two localities, North Elba, where it was first discovered in 1869, and at Jacksons, near Cedar river, where it occurred in 1878. When cut the flesh emits a strong, unpleasant odor. Wounds of the flesh, made by insects or small animals, had a bright-yellow color. When young, the tomentose veil covers the whole plant, but it soon breaks up into scales on the pileus, and partly or wholly disappears from the stem. The color of the spores is darker than in any of the other species of this section.

Boletus Elbensis *Pk.*

Elba Boletus.

Pileus gibbous or convex, smooth, viscid when moist, *dingy-gray or pinkisk-gray*, obscurely virgate-spotted, flesh white; tubes at first *whitish*, nearly plane, adnate or slightly decurrent, rather large, angular, becoming dingy or brownish-ochraceous; stem nearly equal, annulate, *whitish above the annulus*, colored like the pileus below, sometimes slightly reticulated at the apex by the decurrent walls of the tubes; spores *ferruginous-brown*, .0004 to .0005 in. long, .00016 to .0002 broad.

Plant subgregarious, pileus 2 to 4 in. broad, stem 3 to 5 in. long, 4 to 6 lines thick.

Thin woods of larch, spruce and balsam. Adirondack mountains. July to September.

This species is so closely related to the European *B. laricinus*, that it might almost be regarded as a variety of that species. I have separated it because of its smooth pileus and stem. I have never seen the former squamose, nor the latter scrobiculate. From *B. viscidus* it differs decidedly in its coloration.

Boletus Clintonianus *Pk.*

Clinton's Boletus.

Pileus thick, convex, very viscid or glutinous, smooth, soft, shining, varying in color, *golden-yellow, reddish-yellow or chestnut-color*, the margin thin, flesh pale-yellow, becoming less bright or dingy on exposure to the air; tubes nearly plane, adnate or subdecurrent, small,

angular or subrotund, pale-yellow when young, becoming dingy-ochraceous, changing to purplish-brown where bruised; stem equal or slightly thickened at the base, straight or flexuous, annulate, *yellow at the apex*, elsewhere reddish or reddish-brown, sometimes stained with yellow, slightly reticulate at the apex by the decurrent walls of the tubes, annulus *whitish or yellow, persistent*, forming a thick tomentose band about the stem; spores *brownish-ochraceous*, .0004 to .00045 in. long, .00016 to .0002 broad.

Plant single or rarely cæspitose, pileus 2 to 5 in. broad, stem 2 to 5 in. long, 4 to 9 lines thick.

Mossy ground in woods and grassy ground in open places; generally under or near larch trees.

This fine species is apparently the American analogue of the European *B. elegans*, from which it differs in its generally darker color, in its persistent, not fugacious, annulus, and in its stem, which is not at all dotted, either above or below the annulus. It is edible, and has a mild taste in the fresh uncooked state. It has occurred once in Washington Park, Albany, near some larch trees, with which it was probably introduced.

Boletus luteus *L.*

Yellow-brown Boletus.

Pileus gibbous or convex, sometimes nearly plane, viscid or glutinous when moist, virgate-spotted, yellowish-brown, flesh white or yellowish; tubes small, simple, adnate, at first pale-yellow, then dingy-ochraceous; stem *stout*, rather short, annulate, *rough with dots and yellowish above the ring*, brownish-white or yellowish below, the annulus *large, membranous*, whitish or brownish-white; spores ochraceo-ferruginous, nearly fusiform, .0003 in. long, .00015 broad.

Gregarious or rarely subcæspitose, pileus 2 to 5 in. broad, stem 1 to 2 in. long, 5 to 8 lines thick.

Under pine trees, *Pinus sylvestris*. Menands. October.

This is the only instance in which I have observed this species in our State. Possibly it may have been introduced in this place with the young pines under which it was growing. Its annulus is very conspicuous. It is sometimes torn and partly adherent in fragments to the margin of the pileus. In short-stemmed specimens it extends downwards and covers the lower part of the stem like a sheath, resembling in this respect the western *Boletus sphærosporus*, a related species. In other specimens it forms a broad band with the upper margin widely spreading. In the dried specimens the pileus has assumed a dull-brownish or reddish-brown hue. The plant is edible.

Boletus subluteus *n. sp.*

Small Yellowish Boletus.

Pileus convex or nearly plane, viscid or glutinous when moist, sometimes obscurely virgate-spotted, dingy-yellowish inclining to ferruginous-brown. flesh whitish varying to dull-yellowish; tubes plane or convex, adnate, small, subrotund, yellow, becoming ochraceous; stem equal, *slender*, annulate, pallid or yellowish, *marked both above and below the annulus with reddish or brownish glandular dots*, annulus submembranous, *glutinous*, at first concealing the tubes, then *collapsing and forming a narrow whitish or brownish band* about the stem; spores ochraceo-ferruginous, subfusiform, .0003 to .0004 in. long, .00016 to .0002 broad.

Solitary or gregarious, pileus 1.5 to 3 in. broad, stem 1.5 to 2.5 in. long, 2 to 4 lines thick.

Sandy soil in pine woods or groves. Albany and Lewis counties. September and October.

In the Twenty-third Report this fungus was referred as an aberrant form to *B. luteus*, which it much resembles in its general characters. But I find it so constant in its peculiar features that I am disposed to regard it as a distinct species. It differs from *B. luteus* in its smaller size, more slender stem and glutinous collapsing annulus. This never extends downwards so as to sheathe the lower part of the stem, but forms a narrow band with scarcely any spreading margin. Besides the stem is conspicuously dotted both above and below the annulus. The markings of the pileus in this species, *B. luteus* and *B. Elbensis* are similar and resemble little patches of innate brownish fibrils. The species is probably edible, but I have not tested it.

Boletus Americanus *n. sp.*

American Boletus.

Pileus thin, convex or nearly plane, soft, very viscid or glutinous when moist, slightly *tomentose on the margin when young*, soon glabrous or slightly squamose on the margin, rarely wholly squamose-spotted from the drying of the gluten, pale-yellow, becoming dingy or less bright with age, sometimes vaguely dotted or streaked with bright-red, flesh pale-yellow, less clear or pinkish-gray on exposure to the air; tubes plane or convex, adnate, *rather large*, angular, pale-yellow, becoming sordid-ochraceous; stem *slender*, equal or slightly tapering upwards, firm, *not at all annulate*, yellow, sometimes pallid or brownish toward the base, marked with numerous brown or

reddish-brown glandular dots, yellow within; spores *ochraceo-ferruginous*, oblong or subfusiform, .00035 to .00045 in. long, .00016 to .0002 broad.

Gregarious, pileus 1 to 3 in. broad, stem 1.5 to 2.5 in. long, 2 to 4 lines thick.

Under or near pine trees in woods and open places. Very common. July to October.

This is one of our most common species. It is generally associated with *B. granulatus*, from which it is easily distinguished by its thinner pileus, yellow color and more slender stem. As in that and other related species, the stem and tubes exude drops of a turbid milk or juice which hardens and forms the glandular dots seen on them. These are sometimes so numerous that they become confluent. By them and the viscidity of the pileus in this and allied species the fingers become stained in handling the fresh plants. The species is closely related to the European *B. flavidus*, to which our plant has commonly been referred by American mycologists, and under which name it stands in the Twenty-third Report. I am satisfied by more recent investigation that it should be kept distinct, inasmuch as it constantly differs in the character of the veil and the dots of the stem. In *B. flavidus* the stem is described as sprinkled with fugacious glandules above the merely viscous annulus. In *B. Americanus* the stem is dotted from top to base with persistent glandules, there is no appearance of an annulus on it and the veil is somewhat tomentose on the margin of the young pileus. The plant has a slight subacid odor which is perceptible even in the dried specimens. The mycelium is white.

Boletus subaureus *Pk.*

Pale-golden Boletus.

Pileus convex, becoming nearly plane, soft, viscose, *pale-yellow or golden-yellow*, sometimes adorned with darker spots or small tufts of hairs, the margin in the young plant slightly grayish-tomentose, flesh pale-yellow; tubes small or medium size, somewhat angular, adnate or subdecurrent, pale-yellow, becoming dingy-ochraceous; stem equal, *stout*, glandular-dotted, *yellow without and within;* spores *ochraceous-brown*, oblong or subfusiform, .00035 to .0004 in. long, .00016 broad.

Plant gregarious or rarely cæspitose, pileus 2 to 4 in. broad, stem 1.5 to 2.5 in. long, 4 to 6 lines thick.

Thin woods. Albany and Saratoga counties. July to October.

This species resembles *B. Americanus* in color, but differs from it in its thicker pileus, stouter stem and differently colored spores. These have nearly the same color as those of *B. Ravenelii.* In its more robust habit it approaches *B. granulatus.* The minute hairy squamules of the pileus are a peculiar feature, but they are not always present. The glandular dots occur also on the tubes.

Boletus punctipes *Pk.*

Punctate-stemmed Boletus.

Pileus convex or nearly plane, glutinous when moist, yellow, the thin margin at first minutely grayish-pulverulent, becoming recurved with age; tubes short, nearly plane, adnate, small, subrotund, *at first brownish,* becoming sordid-ochraceous; stem rather long, *tapering upwards,* not annulate, glandular-dotted, *rhubarb-yellow;* spores .00035 to .0004 in. long, .00016 to .0002 broad.

Plant gregarious, pileus 2 to 3 in. broad, stem 2 to 3 in. long, 3 to 5 lines thick.

Woods. Gansevoort, Saratoga county. August.

The rhubarb-colored stem and the brownish color of the young hymenium are the distinguishing features of this species. The granulations occur also on the tubes. The species is a rare one, having been found but once.

Boletus albus *Pk.*

White Boletus.

Pileus convex, viscid when moist, *white,* flesh white or yellowish; tubes plane, rather small or medium size, subrotund, adnate, whitish, becoming yellow or ochraceous; stem equal or slightly tapering downwards, not annulate, both it and the tubes glandular-dotted, white, sometimes tinged with pink towards the base; spores *ochraceous,* subfusiform, .0003 to .00035 in. long, .00016 broad.

Plant gregarious or subcæspitose, pileus 1.5 to 3 in. broad, stem 1.5 to 3 in. long, 3 to 5 lines thick.

Pine or hemlock woods. Saratoga county and Adirondack mountains. August to October.

This species is easily known by its white pileus. This, however, becomes dark-colored or brown in drying. The fresh plant sometimes has a peculiar fetid odor, but it does not appear to be constant. *Boletus Boudieri* Q. is a closely related European species. Another European species bears the name *Boletus albus* Gillet, but the name of the American plant, which was published in 1873, has priority.

Boletus granulatus *L.*

Granulated Boletus.

Pileus thick, convex or nearly plane, very viscid or glutinous when moist, variable in color, *pinkish-gray*, *reddish-brown*, *yellowish*, *tawny-ferruginous or brownish*, flesh white or tinged with yellow; tubes nearly plane, adnate, *small*, at first whitish or very pale-yellow, becoming dingy-ochraceous; stem subequal, rather short, not annulate, both it and the tubes marked with glandular dots, whitish or pallid, sometimes yellowish; spores *ochraceo-ferruginous*, subfusiform, .0003 to .00035 in. long, .00016 broad.

Plant gregarious, pileus 1.5 to 3 in. broad, stem 1 to 2 in. long, 4 to 6 lines thick.

Woods, especially of pine, and in open places. Very common. July to October.

The pileus in this species is very variable in color, but it is never wholly white as in the preceding species. Its stem is often dotted to the base, but the dots or granules are generally more numerous and distinct on the upper part. This and *B. Boudieri* appear to be the only European species with exannulate glandular-dotted stems. If we have correctly valued our forms, New York alone has five such species. It is true, they are closely related to each other, and might be regarded by some as mere varieties of a single extremely variable species, but to me the distinguishing characters here given appear to be constant and decisive.

B. granulatus is recorded as edible by most authors. I have not tested it. Gillet remarks that it ought to be regarded at least with suspicion. *B. collinitus* in the Twenty-third Report, *B. flavorufus* Schæff., *B. lactifluus* Sow. and *B. circinans* Pers. are synonyms.

Boletus brevipes *Pk.*

Short-Stemmed Boletus.

Pileus thick, convex, covered with a *thick, tough gluten* when young or moist, *dark-chestnut color*, sometimes fading to dingy-tawny, the margin inflexed, flesh white or tinged with yellow; tubes short, nearly plane, adnate, small, subrotund, at first whitish, then yellowish, becoming dingy-ochraceous; stem *very short*, not annulate, whitish, *not dotted or rarely with a few very minute and inconspicuous dots at the apex;* spores subfusiform, .0003 in. long, .00012 broad.

Solitary or gregarious, pileus 1.5 to 2.5 in. broad, stem .5 to 1 in. long, 3 to 5 lines thick.

Sandy soil in pine woods. Albany county. October.

The species is closely related to *B. granulatus*, from which it differs especially in its copious gluten, darker-colored pileus, shorter stem, and in the almost entire absence of granules from the tubes and stem. When present they are limited to the upper part of the stem and are extremely minute and inconspicuous. It occurs very late in the season. *B. viscosus* Frost is a synonym.

Boletus badius *Fr.*

Bay Boletus.

Pileus convex, even, soft, viscid or glutinous when moist, somewhat shining when dry, *tawny or chestnut color*, flesh whitish tinged with yellow, bluish next the tubes; tubes rather long and large, angular, adnate, *sinuate-depressed*, whitish-yellow, becoming tinged with green; stem nearly equal, rather long, even, paler than the pileus, *brownish-pruinose;* spores oblong, .0004 to .0005 in. long, .00016 to .0002 broad.

Pileus 2 to 3 in. broad, stem 2 to 4 in. long, 3 to 5 lines thick.

Woods. Rensselaer and Lewis counties. August and September.

The dimensions of the spores are derived from the American plant. They are smaller than those given by Karsten for the European plant. We have observed no greenish hue to the tubes nor bluish color to the flesh, and to this extent our specimens are doubtful. The plant needs further examination.

Boletus piperatus *Bull.*

Peppery Boletus.

Pileus convex or nearly plane, smooth, *slightly viscid* when moist, *yellowish, cinnamon or subferruginous*, flesh white or yellowish, *taste acrid*, peppery; tubes rather long and large, angular, plane or convex, adnate or subdecurrent, *reddish-ferruginous*, generally more highly colored than the pileus: stem slender, nearly equal, tawny-yellow, *bright-yellow at the base;* spores *ferruginous-brown*, subfusiform, .00035 to .00045 in. long, .00016 broad.

Pileus 1 to 3 in. broad, stem 1.5 to 3 in. long, 2 to 4 lines thick.

Woods and open places. Common and variable. July to October.

The species is readily known by the peppery taste of the flesh, and the bright yellow color of the base of the stem. The pileus is sometimes rimose-scaly or rimose-areolate. It is less viscid than most other species of this section. The color of the spores is similar to that of the spores of *B. Elbensis*. *B. ferruginatus* Batsch. is a synonym.

EXPLANATION OF PLATE 1.

Ombrophila rubella *Quel.*

Fig. 1. Fragment of bark bearing the fungus.
Fig. 2. A plant and its matrix magnified.
Fig. 3. A branched filament bearing four clusters of spores magnified.
Fig. 4. Five spores, × 400.

Geoglossum vitellinum *Bres.*

Fig. 5. Five plants of various forms.
Fig. 6. Three asci; two containing spores and two united below.
Fig. 7. Four spores, × 400.

Periconia albiceps *Pk.*

Fig. 8. Piece of a stem bearing the fungus.
Fig. 9. Two plants magnified.
Fig. 10. Filaments of the head; two of them bearing spores, × 400.
Fig. 11. Four spores, × 400.

Helotium fraternum *Pk*

Fig. 12. A petiole bearing four examples of the fungus.
Fig. 13. Two plants magnified.
Fig. 14. A paraphysis and an ascus containing spores, × 400.
Fig. 15. Three spores, × 400.

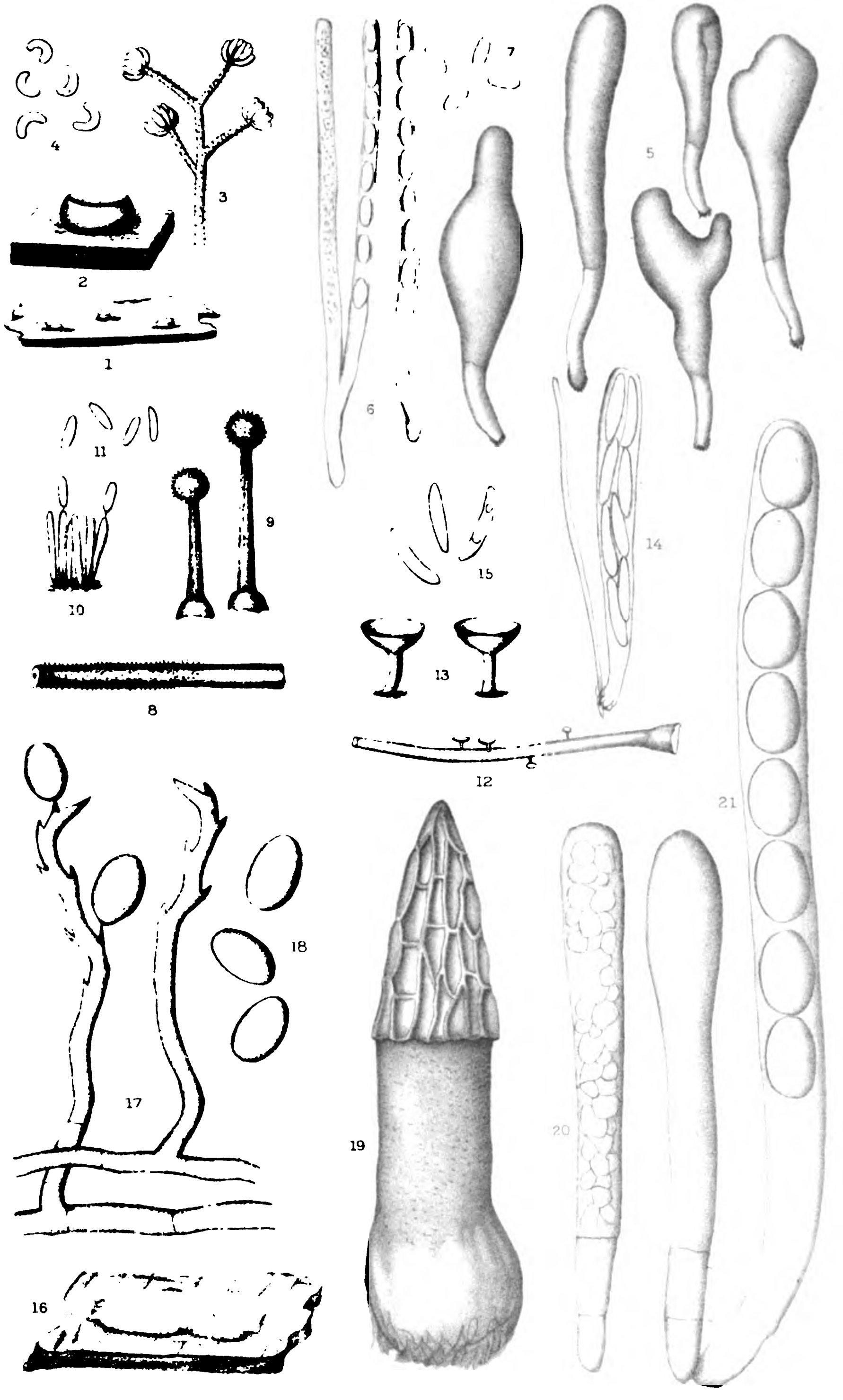
Acremonium flexuosum *Pk.*

Fig. 16. A piece of wood bearing the fungus.
Fig. 17. Branching filaments; one of them bearing two spores, × 400.
Fig. 18. Three spores, × 400.

Morchella angusticeps *Pk.*

Fig. 19. A plant of medium size.
Fig. 20. Two undeveloped asci; one containing crowded nuclei, × 400.
Fig. 21. An ascus containing spores, × 400.

FUNGI.



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EXPLANATION OF PLATE 2.

Peziza leucobasis *Pk.*

Fig. 1. A piece of wood bearing the fungus.
Fig. 2. A plant magnified.
Fig. 3. A paraphysis and an ascus containing spores, × 400.

Peziza orbicularis *Pk.*

Fig. 4. A plant and its matrix.
Fig. 5. A paraphysis and an ascus containing spores, × 400.
Fig. 6. Three spores, × 400.

Gorgoniceps turbinata *Sacc.*

Fig. 7. Piece of a branch bearing the fungus.
Fig. 8. A plant magnified.
Fig. 9. A paraphysis and an ascus containing spores, × 400.
Fig. 9′. A spore, × 400.

Glomerularia Corni *Pk.*

Fig. 10. A leaf spotted by the fungus.
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Fig. 13. A mass of adhering spores, × 400.
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Péziza longipila *Pk.*

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Boletus rubinellus *Pk.*

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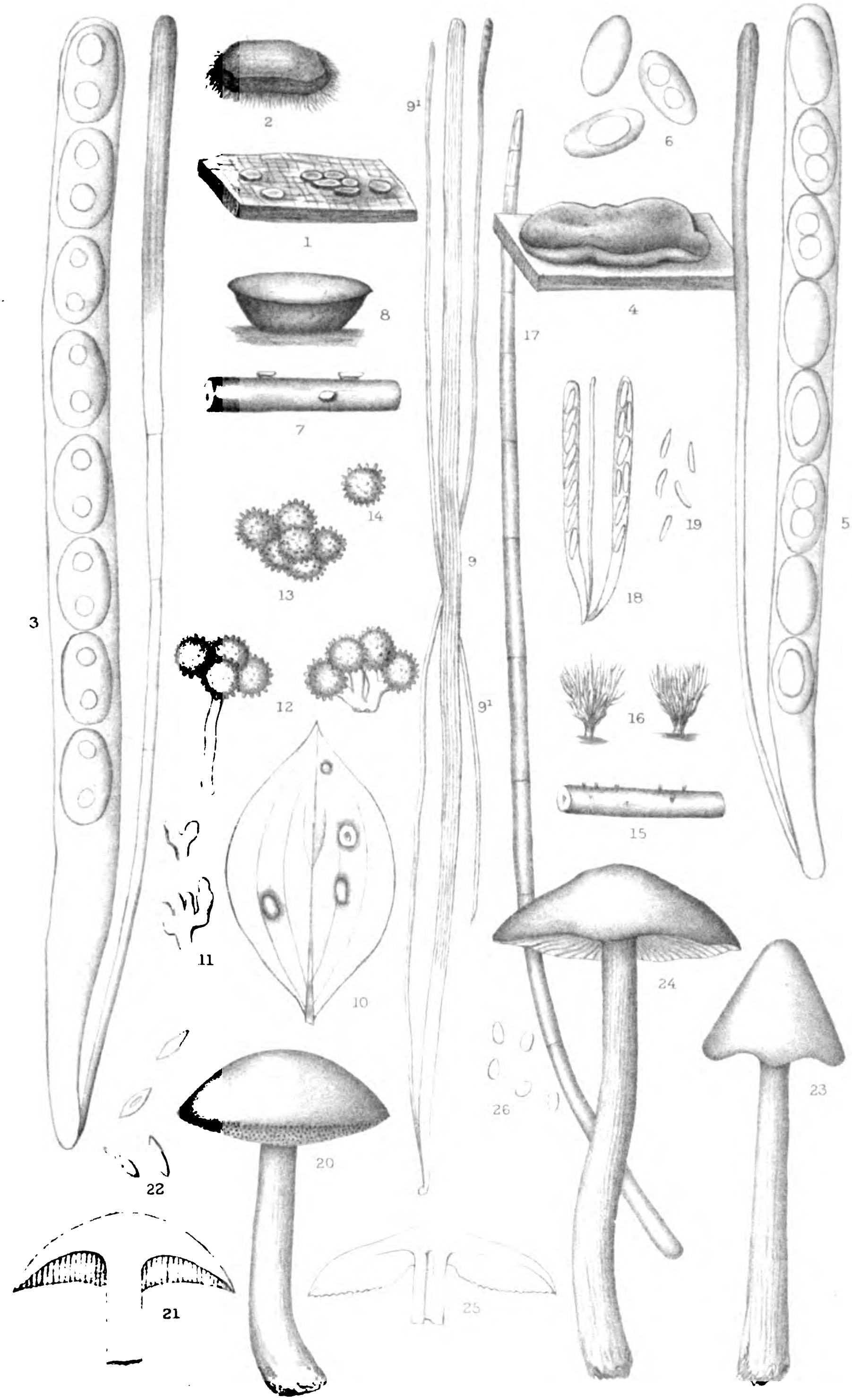
Fig. 21 Vertical section of a pileus and upper part of the stem.
Fig. 22. Four spores, × 400.

Collybia hygrophoroides *Pk.*

Fig. 23. A young plant.
Fig. 24. An older plant with the pileus more expanded.
Fig. 25. Vertical section of a pileus and upper part of the stem.
Fig. 26. Five spores, × 400.

FUNGI.



Chas. Van Benthuysen & Sons, Alban.

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BULLETIN

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NATURAL HISTORY.

No. 3.
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BUILDING STONE IN THE STATE OF NEW YORK,

BY JOHN C. SMOCK.

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PREFACE.

Economic geology, as a division of the New York State Museum, has for its work the examination and description of the mineral staples which occur in the State. An account of the building stones, and a notice of them, in the form of a bulletin, was proposed in the autumn of 1886. The work of visiting the quarry districts and collecting the necessary data was begun in October of that year, and occupied parts of two field seasons. All of the large quarries were visited, and notes of their location, extent and business were gathered. Many rock specimens, representative of the varieties of stone quarried, were obtained. It was impossible to go to all the localities; and circular letters, asking for information, were sent to them, so far as they were known. The many answers which have come from quarry owners and managers, have filled, in part, the gaps in the field notes, and furnished the material for the descriptions of these localities.

The scope of the work, as planned, included the location, extent, geological relations and ownership of the quarries, and their statistics of capital, plant, labor, product, markets and prices. It was soon found that full and accurate data from each individual owner, in answer to all of the inquiries, were not to be had. The statistics, relating more particularly to the business, were then sought from the large property owners and managers, who could give close estimates for their own districts. Their answers came promptly; and the information from them is more nearly accurate than any census made up of the individual statements of quarrymen.

Another aim in the work was to make collections of specimens, and to have the microscopic examinations, chemical analyses and physical tests made of them, which would show their composition, structure, hardness, strength, durability, and comparative value as constructive material. The field collections are yet too incomplete; and the examination and study of specimens is reserved, necessarily, for a subsequent bulletin.

In the preparation of this bulletin the aim has been to make the descriptive notes plain and serviceable to all interested in the subject, and to exclude the purely scientific observations of the field, leaving them to be incorporated with the discussion of the occurrence, properties and general, economic relations of the building stone, which is used in our State.

In conclusion, I must acknowledge my indebtedness to the many quarry owners, managers and superintendents, who have kindly given their time and attention, in contributing valuable notes and statistics. Special acknowledgments for data of quarry districts are due to Messrs. Samuel Coykendall and Samuel Coles, of the Union Blue Stone Company, of New York; Gilbert Brady, Rochester; L. D. Leonard, Albion; C. A. Gorman, Medina; Edward Merritt and Thomas S. Clarkson, Potsdam; D. A. Parmeter, Hammond; Thomas J. Whitney, Gouverneur; David Black, of the Thousand Island Granite Company, Thurso; Jas. Hughes and Wm. Crabtree, Syracuse; N. Hewitt, Amsterdam; W. A. Nixon, and Edward Willis of the Penryhn Slate Company, Middle Granville; Wm. B. Fitch, Kingston; and F. G. Clarke, Oxford.

To Prof. James Hall, State Geologist, I am indebted for many facts bearing on the geological horizon of our quarries.

JOHN C. SMOCK.

NEW YORK STATE MUSEUM,
ALBANY, N. Y., *March* 5, 1888.

CONTENTS.

GENERAL

Classification and Arrangement.

Any division of the building stones (or stone used in construction), which occur naturally, is to some extent arbitrary. The basis for it may be in the nature of the rock as to its constituent minerals, their arrangement and their relative proportion in the mass, or it may be in the formation, or geological horizon whence it comes. The latter has regard to the source rather than the nature or kind of rock. Thus granites and gneisses differ in the arrangement of the minerals which make up the rock or stone and not, necessarily, in the minerals or even in their chemical composition. Again, for example, limestones and marbles differ in the degree of crystallization and not in chemical composition. Then, again there are sandstones, slates, serpentines and trap-rocks, classes which differ mineralogically and chemically. From the stand point of geology the natural building stones may belong to widely different geological formations or ages and yet in their composition be almost identical. Sandstones and limestones especially are widely represented in the various formations. Marble may come from the oldest or Archaean or from the Silurian or from the later geological rock outcrops. In our own State the Tuckahoe and Sing Sing marbles, the coral-shell marble of Hudson, the Glens Falls black marble and the Lockport marble are representatives of different geological epochs. And the so-called *granites* comprehend rocks, which differ in their mineralogical constitution and in the formation to which they belong. The division or arrangement, which is indicated by the geological age is, therefore, not so natural or definite as the former. But it is serviceable in a secondary division or subdivision of the classes, which rest upon mineral differences.

The best classification is, primarily into the *kinds* of rock or stone, and, secondarily, into groups corresponding to the several geological formations. The first are fully recognized in the practical and business circles; the geological grouping also is known, but is not so generally appreciated and understood. In New York the characters of some of the geological subdivisions have been so carefully studied as to become well known, and they are so persistent that they are types. The Black River limestone, the Trenton limestone, the Onon-

daga gray limestone, the Potsdam sandstone, the Oneida conglomerate and the Medina sandstone are nearly as well known and as readily recognized by the practical quarrymen as by geological experts. And in the State the outcrops of these formations are to some extent natural divisions, whose topography and general surface characters are due to these rocks. Hence in the geographical distribution of the several kinds of rock or stone, the limits are determined by the extent of the geological formations. And a geological map of the State shows where they may be found.

The arrangement, as indicated above, is into the following kinds of rock and the geological groups to which they belong:

KINDS OF ROCK.

I. CRYSTALLINE ROCKS.

1. Granites, syenites, gneisses, mica schists.
2. Trap-rocks.
3. Marbles, serpentines.

II. SUB-CRYSTALLINE AND FRAGMENTAL ROCKS.*

1. Quartzytes and sandstones.
2. Limestones.
3. Slates.

The rocks of the sub-crystalline and fragmental division are subdivided and arranged in the following geological groups:

SANDSTONE.

Potsdam.	Portage.
Hudson River group.	Chemung.
Medina.	Catskill.
Clinton group.	New Red Sandstone.
Hamilton.	

LIMESTONES.

Calciferous.	Lower Helderberg.
Chazy.	Upper Helderberg.
Trenton.	Tully Limestone.
Niagara.	

* Many of the rocks in this second general head are crystalline or sub-crystalline; but as the structure in nearly all cases is not recognizable by the unaided eye, the division is consistent with practice and is retained. The strictly fragmental rocks are slates, sandstones and conglomerates. Building stones are sometimes classified as crystalline, sedimentary and calcareous rocks.

GEOLOGICAL POSITION

—AND—

Geographical Distribution of Building Stone

IN NEW YORK.

The crystalline rocks are limited in the outcrops to the Adirondack region, the Highlands of the Hudson,* Westchester and New York counties, the Rockland county trap range, Staten Island and a very small area on Long Island. The Hudson-Champlain valley, a part of the St. Lawrence valley and the central, southern-central and western parts of the State have sandstones and limestones as *native* building stone.

The geological horizon, the occurrence, the localities and general notes on the building stone of the several subdivisions or groups are given here under their respective heads.

I.—CRYSTALLINE ROCKS.

§ 1. *GRANITES, SYENITES, GNEISSES, MICA SCHIST.*

Granite, in its proper signification, is a crystalline rock, consisting of feldspar, quartz and mica. These constituents are aggregated together in an intimate mixture and in varying proportions. The minerals may be of larger or smaller size, from the scarcely discernible grains or crystals to masses an inch or more in length; and hence the stone is said to be coarse-grained or fine-grained, or coarse crystalline and fine-crystalline. But the typical granite is not the more common form or variety. Besides the essential, constituent minerals, there are hornblende, pyroxene, epidote, garnet, tourmaline, magnetite, pyrite, chlorite, graphite, any of which may come in as accessory minerals. Generally some one of these minerals is present

* The crystalline rocks of eastern Dutchess county and a part of Columbia are included in the Highlands.

and gives character to the mass. Often it happens that the mica is almost entirely wanting, and is replaced by one of these accessory constituents. Thus there may be a hornblendic granite or a graphitic or epidotic variety, etc., according to the nature of the mineral.

Syenite differs from granite in having little quartz, no mica and hornblende.

Parallel in composition with granites, but differing in texture, are the gneisses or gneissic rocks. They are stratified or lie in strata or beds. In them the minerals are in thin, lenticular layers and laminæ which are parallel to the bedding-planes of the rock. The mass is said to be laminated, or schistose in structure. Sometimes the component minerals are so large that in hand specimens it is not possible to decide if they be gneiss or granite. And they may be fine-granular and coarse-granular in texture. Graphitic, epidotic, hornblendic, garnetiferous and other varieties occur, determined by the accessory constituents.

Mica schist is an aggregate of quartz and mica mainly and having a more marked schistose structure than the gneisses. The lenticular form of the quartz is especially noticeable. And on account of its structure it is more readily split in the plane of its bedding than the granites or the gneisses. Generally the plates or scales of mica lie rudely parallel to one another and they help in giving the mass a more laminated appearance and cause it to have a more fissile character.

It must be understood that there is a wide range in the relative proportions in which these essential, rock-forming minerals occur in these several kinds of crystalline rocks. One or another may predominate and give character to the mass. As in the deposits which are to-day in process of formation, these old rock masses differ within narrow limits. And not only do we find variation from one locality to another, but also in the same ledge and quarry, and in some places in the same bed. These mineralogical differences generally indicate a different chemical composition also, although not in all cases. But to the quarryman and builder the former are of much more importance, since they give strength and make it durable, or determine its cleavage and the style of working. The texture is wholly controlled by the mode of aggregation and the nature of the minerals. Where uniformly distributed and not in lines or layers the mass is split with equal ease in any direction, and it is capable of being dressed with like degree of fineness on any side. But such crystalline aggregates

are rare and nearly all of the granite and syenite can be cleft in one way more readily than in another, that is, the stone is said to have a *grain* to it. The durability also is affected by the nature of the minerals. Thus, pyrite may occur, and by its decomposition cause decay. Or there may be a more easily decomposing feldspar which by its decay will make the mass to crumble. Or by an excess of mica the stone may be particularly liable to split or scale off, when exposed to the action of freezing weather. Owing to these almost infinite variations in composition and, consequently, in structure and texture no general description will cover all the forms and varieties. But it may be said here that there is comparatively little of the massive and unstratified (granites and syenites) varieties. The greater part of the crystalline rocks, particularly in the south-eastern part of the State, occurs in beds as schistose gneisses and granitoid and syenite gneisses. The stratified condition is predominant in all the border of the Adirondack region also.

The term granite is applied to rocks found in great masses and outcrops over large areas in the central and eastern portions of the Adirondack region, which are not strictly such. Instead of potash feldspar they have a lime feldspar (labradorite) and with it quartz and hornblende.

Granites, syenites, gneisses and mica schist occur in the counties of Rockland, Orange, Westchester, Putnam and Dutchess and on New York island. For constructive material quarries have been opened at many points, generally near railway lines or on the Hudson river. The Breakneck and Storm King mountain granite quarries were opened many years ago, and described in Mather's report on the First District of the State. Gneiss has been quarried at Spuyten Duyvill; near Hastings; at Valentine's, east of Yonkers; at Fordham; near Hartsdale; at Kensico; at Tarrytown, in Westchester county; at Ganung's quarry, west of Croton Falls; at Cold Spring and near Anthony's Nose, north-west of Peekskill in Putnam county; at Ramapo, in Rockland county; and in Orange county, at West Point, Cozzens and Fort Montgomery. There are many other localities where stone has been quarried for local use, which are not worked for export, or steadily as quarries. The outcrops of gneissic rocks are so numerous and so extensive that the supply is inexhaustible, and the number of quarries which can be opened is equalled only by the area of territory covered by these outcrops. Particularly advantageous locations are to be seen along the Hudson river from

Peekskill to Fishkill, in the Highlands. The Ramapo river valley, which is traversed by the New York, Lake Erie and Western railroad, the Harlem, the New Haven, and the New York City and Northern railroad lines, cross the territory of these crystalline rocks. Mica schist and micaceous gneisses occur on New York island, in Westchester county, and in the eastern parts of Putnam and Dutchess counties. They are quarried wherever they are conveniently had, for home use and generally for common wall work and foundations. A great amount has been used in New York city in foundations and in backs of walls with other stone as face material. In the great Adirondack region and its bordering zone of crystalline rocks, occupying Essex and Hamilton, and large parts of Clinton, Franklin, St. Lawrence, Jefferson, Lewis, Herkimer, Fulton, Saratoga, Warren and Washington counties, there is a great variety in the outcrops, but comparatively little work has been done, excepting at a few places on the outskirts of the region, to develop quarries of granite or gneiss. In Saratoga county a quarry in Wilton is worked for paving-blocks. In Essex county quarries have been opened in recent years in Willsborough and near Keeseville. On the north-west there is a quarry near Canton in St. Lawrence county, and the quarries on Grindstone island in the St. Lawrence. At the extreme southern end of the region where it reaches the Mohawk gneiss is quarried to a considerable extent at Little Falls. Other localities are in Greenfield and Hadley, in Saratoga, and at Whitehall in Washington counties.

The want of transportation facilities in all the great interior, the distance from the great city markets, which call for granites particularly, and the more accessible outcrops of limestone and sandstone, which border it, and are nearer the towns and lesser markets, are against the opening of granite quarries in the Adirondack region. Future exploration will no doubt lead to the discovery of beautiful and valuable stone, and the building of railroads will bring them to notice and to market. On the line of the Adirondack railroad and the lines of the Delaware and Hudson Canal Company, and on the shore of Lake Champlain, the work of opening new quarries is in progress and is promising of profitable results. On Grindstone island, near Clayton, Jefferson county, a very large quantity of granite has been quarried for western markets.

2. TRAP-ROCK.

Trap-rock is the common name given to a certain class of eruptive or igneous rocks, which are unstratified. They are made up of a feldspar (usually labradorite) and augite, with some magnetite and titanic iron. The mass is generally of a dark color and finer-grained than the granites. The rock of the Palisades opposite New York city is an example. In New York these trap-rocks make up the Palisade mountain range and the Torne mountain, on the west side of the Hudson river from the New Jersey line to Haverstraw. There is an outcrop on Staten Island also, where the rock was quarried under the name of *granite*. The only place where the stone is steadily worked is on the river bluff at Rockland Lake.

The existence of unstratified rocks of this group in the Adirondack region is known, but of their extent and localities there is much uncertainty. Their importance as a source of material for constructive uses is inconsiderable where there is so much granite, gneiss and other stone which are worked more economically and dressed more readily.

3. MARBLES.

Marble has been defined to be "limestone which has a granular texture." But as already noted, the term is used in New York State to apply to any calcareous rock which takes a fine polish and may be used as an ornamental or decorative material. In this report the term is restricted to the crystalline limestones, whether massive or unstratified, or metamorphosed or altered sediments. The texture and not the use is the basis of the distinction between ordinary limestones, which are not crystalline, and the marbles. Crystalline limestone is a common rock in Westchester, Putnam and in the eastern part of Dutchess counties. There are small outcrops in Orange county also. The Adirondack region has its belts of the same rock. And, in general the territory of the granites, gneisses and syenites contains here and there patches of crystalline limestone, and also possible sources of marble. Marble has been quarried at King's Bridge and Tremont in New York city; at Tuckahoe, Scarsdale and Pleasantville near the Harlem railroad line; at Hastings, Sparta and Sing Sing on the Hudson river; and at South Dover and Dover Plains in the eastern part of Dutchess county. In the Champlain valley there is a quarry at Port Henry. On the north-west side of the Adirondacks there are large quarries at Gouverneur.

As a supplement to this list the "*coral shell marble*" near Hudson and the "Lepanto" marble near Plattsburgh are here added.

When the calcareous rock contains some serpentine the term verd-antique marble is given to it. And such a marble has been quarried in the town of Thurman, Warren county.

The geological age of the crystalline limestones, which occur in the State, and which are known by quarrymen as marbles, is, in some cases, doubtful. The outcrops in the Highlands of the Hudson and in the Adirondack region are probably all Laurentian. The belt in the eastern parts of Dutchess and Putnam counties, which in its northern extension is one with the Vermont marble region, is metamorphosed or altered Trenton limestone. The Westchester marbles may belong in the same horizon.

II.—SUB-CRYSTALLINE AND FRAGMENTAL ROCKS.

1. SANDSTONES AND QUARTZYTES.

Sandstones are rocks made up of grains of quartzose sand, which are cemented together by siliceous, ferruginous, calcareous or argillaceous material. In some cases mica, feldspar or other minerals, are mixed with the quartz sand, and then they are termed micaceous, feldspathic, etc. From the nature of the cement holding the grains together the rocks are variously designated as ferruginous, or iron sandstone, or sometimes brownstone, as calcareous sandrock, etc. The component parts may be coarse-grained or fine-grained. There is an almost infinite variety in respect to shades of color, degree of texture and nature of cement. And the hardness, strength, density and durability are determined by these elements. Their value as building material depends upon the physical constitution quite as much as upon the chemical composition. Without a good bond the grains fall apart and the stone is friable or crumbling. If the cementing material be one which decomposes readily, as in the case of some of the more argillaceous or shaly varieties, or in the calcareous sandrocks, the whole mass is soon reduced to sand. Examples of sandstones, weak through such causes, are common. When the quartz grains are, as it were, run together and form a kind of vitrified mass the rock is termed a quartzyte. It looks as if the sandstone had been altered and partially fused. In some cases these quartzytes have a crystalline appearance, especially when feldspar occurs with the quartz. Sandstones are found widely distributed

over the State outside of the crystalline rock regions of the Hudson Highlands and the Adirondacks. And they represent all of the geological periods, beginning with the Potsdam, up to the New Red Sandstone. Following the order as given on page 8, the occurrences and localities may be noted briefly.

Potsdam Sandstone.

This formation in narrow outcrops is seen in Dutchess county, bordering the Archæan rocks. Outcrops of limited areas are seen in the Mohawk valley at several points between Fonda and Little Falls. In the Champlain valley this formation has been a source of building stone at Fort Ann, Whitehall, Port Henry and Keeseville. North of the Adirondacks there are quarries at Malone, in Franklin county. The most extensive quarries of this sandstone are on the Raquette river near Potsdam, and in Hammond, St. Lawrence county. At the last named place the product is largely paving blocks and curbing stone, and is made out of a grayish-white, thin-bedded sandstone. The Potsdam rock occurs in moderately thick beds, and is a hard, compact stone of a pink to light buff shade of color. Some of it has a laminated structure and striped appearance. It is an excellent building stone, and is widely known and esteemed for its beauty and durability.

Hudson River Group.

This group includes shales and standstones. The latter are generally shaly or argillaceous. There are some localities where more siliceous or arenaceous beds are found. And these latter beds furnish the building stone. As is well known, the formation follows the Hudson River valley from the Highlands northward to Washington county and the valley of the Mohawk west, and then runs north-west in a broader belt across Lewis and Oswego counties to Lake Ontario. Owing to the shaly nature of the sandstone, the localities for quarries are few. They have been opened on the Hudson river at Highlands, nearly opposite Poughkeepsie, at Rhinecliff (Rhinebeck station), near Tivoli, on the river between Stuyvesant and Schodack, at New Baltimore and at Troy. In the Mohawk valley there are quarries at Aqueduct, in Schenectady, on Frankfort Hill in Herkimer county, east of Rome in Oneida county, and in the town of Orwell in Oswego county.

The Hudson river formation does not supply much, if any, stone to markets outside of its limits. And nearly all of what is quarried

in it is used in foundations and common wall work. Granites, limestones and other sandstones are taking the place of the stone from its quarries; and some of these quarries are abandoned.

Medina Sandstone.

Siliceous rocks, principally sandstones, predominate in this formation. They crop out in the flanks of the Shawangunk mountain in Orange and Ulster counties. In the western part of the State the Medina sandstone borders Lake Ontario from the Niagara river to Oswego, and thence continues in an eastward course through Oswego and Oneida counties nearly to Rome. In the Shawangunk range the red or brown-red sandstones occur with some gray-white sandstones and some shales. And excepting two or three very small quarries it is not a source of building stone. The stone is generally hard and is not easily dressed. In the western part of the State the sandstone is associated whith shales and shaly sandstone. The mass is made up of quartzose sand in fine grains, cemented more or less strongly by siliceous and ferruginous matter. The prevailing color is a brown or brown-red, but gray-white and variegated red and white also are common shades. In texture the mass is usually fine-grained. The strata lie dipping at a small angle southward, and the stone is remarkably even bedded. At nearly all localities two systems of joints, at right angles to one another, divide the rock into blocks, which help the quarryman in his work. Quarries in this formation have been opened and worked at Fulton, Granby and Oswego in Oswego county; at several points in Wayne county; at Rochester and on Irondequoit creek and Brockport in Monroe county; at Holly, Hulberton, Albion and Medina in Orleans county; and at Lockport and Lewiston in Niagara county. The quarries at Hulberton, Albion and Medina are among the largest in the State. And the stone therein quarried has acquired a well-deserved reputation for rich color, its strength and its durability as a building material. And the name of the formation (from the town of Medina), has come to be used for all the product of the many quarries in it.

Clinton Group.

The rocks of this group are mainly shales. Impure limestone and some sandstone also occur. They form the outcrop in a narrow belt of country from Herkimer county west to the Niagara river and bordering on the south the Medina sandstone. Sandstone has been obtained

from this formation in the southern part of Herkimer county, and at Clinton and at Higginsville in Oneida county.

Oriskany Sandstone.

This sandstone is generally too friable to make a good building stone; and no quarries of importance are known in it.

The sandstones of the CAUDA GALLI and of the SCHOHARIE GRITS are either argillaceous, and therefore not durable, or too porous and loosely cemented to make good building material. No doubt, localities could be found where some of the beds may be compact and solid, and may be quarried profitably for local use. The MARCELLUS SHALE, a more shaly formation than either of them, has furnished stone for building at Chapinville in Ontario county.

Hamilton and Portage Groups.

The rocks of these geological groups are shales, slates and sandstones. But there is so great a range in composition and texture that there are many varieties under each of these heads and an almost infinite gradation from one to another; and no sharp lines of demarcation or division can be drawn. And the notes on the sandstones of the Hudson River group apply here also.*

In the Hamilton group, and above it, in the Oneonta sandstone in the eastern part of the State, there is a great development of gray, hard, compactly aggregated sandstone, which is thin-bedded or can be split on planes parallel to the bedding, and which is known as flagstone. This variety predominates in the upper part of the Hamilton formation, and continues into the Portage, or its equivalent here—the Oneonta sandstone. In the central part of the State, where this group is recognized, in a belt south of the Mohawk valley, in Otsego, Chenango, Madison, Cortland, Cayuga and Seneca counties, the sandstone is more or less mixed with shale and slate in irregularly alternating strata. And olive, greenish and yellowish shades of color prevail. In the western part of the State—that is, in the belt, stretching from Seneca lake to Lake Erie—through Ontario, Livingston, Genesee and Erie counties, the olive and bluish-gray shales predominate, and the sandstone is not abundant nor of the best quality for a building stone.

The Portage rocks in the western part of the State have been divided into shales at the base; then shales and flagstones; and the Portage sandstone at the top. In the last division thick beds with

*See pages 15 and 16.

little shale are marks of this horizon. And the stone is generally fine-grained. The line of division between the Hamilton and the Portage cannot here be indicated geographically, and the quarries are placed in one subdivision under the heading as above. The outcrops have been, in general, indicated as running through the Hudson valley east of the Catskills, and turning west, in a broadening belt south of the Mohawk valley and through the central plateau region and the western part of the State to Lake Erie.

The number of quarries in this belt of Hamilton-Portage is large. The greater part of all the Hudson river flagging comes from it. And there are hundreds of quarries opened in Sullivan, Orange, Ulster, Greene and Albany counties. The Guilford and Oxford quarries are in it. In the lake region, the Atwater, Ithaca, Trumansburgh, Watkins Glen, Penn Yan and the Ontario county quarries are all probably in it. Going west, the Portage and Warsaw quarries belong in the Portage horizon.

Chemung Sandstone.

The Chemung rocks also are shales and sandstones principally, but the proportion of shaly sandstone appears to be greater than in the Portage; and they are more commonly thin-bedded, and on the weathered surfaces or outcrops are olive to brown shades of color. On account of this prevalence of the shaly and inferior sandstones there is less building stone obtained from this formation, excepting the common grades, which are quarried largely to meet local demands and supply the towns in the territory on the outcrop. The Chemung rocks occupy the southern tier of counties from Lake Erie eastward to the Susquehanna. Good building stone is obtained from this formation at Elmira and Corning. The Steuben county quarries are in it. There are small quarries in Allegany county also in it. Jamestown gets its stone in part from it. And small quarries have been opened in Chautauqua county at other points which are referred here. The Olean quarry in Cattaraugus may be Chemung.

Catskill Sandstone.

The Catskill group is developed in a great thickness of sandstones, grits and siliceous conglomerates in the Catskill mountain region, in Sullivan, Delaware, Broome, Otsego, Schoharie and Greene and Ulster counties. Much of the sandstone is coarse-grained and hard to dress; and oblique lamination and cross-bedding also are common, which make it work badly. Excepting for flagging, little of the

Catskill sandstone is quarried. The region has no large towns in it, and hence no large local markets which would call for any considerble amounts of building stone. There are, however, some good quarries, which are worked for flagging, chiefly, along the N. Y., O. & W. R. R. and the U. & D. R. R. lines in Ulster and Delaware counties; and in the Catskills in Greene county there are quarries in Lexington, Jewett, Windham, Hunter and Prattsville.

New Red Sandstone.

The formation, which is known as the New Red Sandstone, or simply as the Red Sandstone, is limited to a small triangular area in Rockland county, between Stony Point and the New Jersey line. The sandstones of this formation are both shaly and arenaceous; and the varieties grade into one another from the fine, shaly beds to fine conglomerates. The prevailing colors are dark red to brown,—whence the term *brownstone.* The cementing material is largely ferruginous. The formation in its extension south-west in New Jersey, furnishes the brownstone of the Belleville and Newark quarries so extensively employed as a building stone in New York and the adjacent cities. The famous "Connecticut brownstone" and the Longmeadow sandstone of Massachusetts come from the same formation in the Connecticut valley. The larger and more important quarries in this sandstone in Rockland county are in the west side of the Hudson river, between Piermont and Nyack and near Haverstraw, in the eastern slope of the Torne mountain. The oldest quarries were opened first about a century ago; and they were worked extensively for many years. The principal market was New York city, and the stone was sold for flagging, house trimmings, common walls and rubble stone. As the quarries were convenient to navigation and near a great market the business was large, until other stone came in to compete successfully with it. And the quarries have been abandoned and their sites taken for villas and town lots, for which their value exceeds that of quarry ground. At present there are only two quarries at work, between Nyack and Piermont. They furnish flagstone and dressed stone for building. The quarries near Haverstraw are not worked steadily. There are small openings near New City, near Congers station and at Suffern, and probably at a few other places, but all of them do a local business.

In New York city and in the towns on the Monmouth county shore of New Jersey this stone is sometimes called "Nyack stone" or "Haverstraw stone."

2. *LIMESTONES.*

Limestone is essentially carbonate of lime, but it always contains some additional constituent; and the more commonly occurring impurities, or accessory matters are silica in the form of quartz, clay, iron and magnesia. And limestones are said to be siliceous, argillaceous, ferruginous, magnesian and dolomitic, according as they contain one or another of these constituents. Other foreign mineral matter may be found in them, and in places so as to give character to the mass. The texture also varies greatly. It may be coarse or fine crystalline, sub-crystalline, or amorphous, according as the crystals which make up the mass are larger or smaller, or are not recognizable by the unaided eye. The terms coarse-grained and fine-grained may apply when the mass resembles sandstone in its granular aggregation. And it may be hard and compact, almost vitreous, or loosely cemented and crumbling with slight pressure like sugar, or, again, like chalk, dull and earthy. From this general statement of the range in composition and texture, it follows that there is an equally wide variation in the hardness, strength and durability of limestones. Some are hard and strong, surpassing in their resistance to crushing force, many granites, and nearly as durable as the best sandstone; others are friable and fall to pieces under slight pressure, or they are dissolved rapidly by atmospheric agents. Wherever the admixture of silica is large and the texture is compact, the stone is hard and durable; hence the siliceous limestones are generally among the most enduring building stones. The magnesian and dolomitic varieties also are good stone. In color the prevailing shades are grey-blue, and yellow to white. As stated on a previous page, the limestones which are quarried for building stone in this State are found in the following named formations: Calciferous, Chazy, Trenton, Niagara, Lower Helderberg, Upper Helderberg or Corniferous and Tully limestones. The geographical distribution of the several limestone formations is here given in the same order—that of the geological succession, beginning with the Calciferous sandrock.

Calciferous.

Although termed a Calciferous sand-rock, very much of the rock thus designated is, properly, a magnesian or a siliceo-magnesian limestone. Some of the blue limestone which is quarried in Orange county and the New Hamburgh quarry in Dutchess county are probably of this epoch. The calciferous is traced along the Mohawk

valley, in Montgomery, Herkimer and Oneida counties. The quarries at Little Falls, Canajoharie and other smaller openings, are in it. The Sandy Hill quarry also is apparently in the same horizon. Generally the stone of this formation is in thick beds, siliceous, hard, strong and durable.

Chazy Limestone.

The Chazy formation is seen in Clinton county in its typical locality. It is non-magnesian and less siliceous than the Calciferous. The beds are thick and often uneven. Regular joints are common, dividing it into rectangular masses and helping the quarrymen in extracting the stone. It affords strong and heavy stone at quarries in the Champlain valley, at Willsboro Point and near Plattsburgh.

Trenton Limestone.

The Trenton here includes the Birdseye, Black River and Trenton formations. And it occupies the Mohawk valley, the Champlain valley, a border zone around the south-western and western sides of the Adirondack region, and the St. Lawrence valley, from the Canada line south-west to Lake Ontario. The counties of Montgomery, Fulton, Herkimer, Oneida, Lewis, Jefferson, St. Lawrence, Hamilton, Clinton, Essex, Warren and Saratoga have outcrops of limestones which are referred to the Trenton age. Many quarries in the Mohawk valley; the quarries at Prospect and Holland Patent in Oneida county; Lowville in Lewis county; Watertown, Chaumont and Three Mile Bay in Jefferson; Norwood and Ogdensburg in St. Lawrence; and Glens Falls are opened in these limestones. There is much variation, from the dark-colored, compact marble of Glens Falls to the gray, fine-crystalline stone of the Prospect quarries. And these variations are often seen in vertical sections of comparatively few feet, so that the same quarry may yield a *marble* and a coarse, rough stone fit for common walls only. Hence no general description is applicable to the formations as a whole; and it is impossible to assign all of the quarries to their proper horizon. In fact, in some of the quarries two formations are represented.

Niagara Limestone.

This formation has its great development near the Niagara river and the Lockport and Rochester limestone quarries are in it. At Lockport it is a gray, thick-bedded, sub-crystalline stone, which has been used widely for building.

Lower Helderberg Group.

This group includes a wide variation in its limestones, and no general statements apply to the several horizons alike. The formation is traced from the Helderberg mountains westward, south of the Mohawk river nearly to Syracuse. The lower beds (Tentaculite) are dark-colored, compact, thick, and afford a stone which can be polished. The Pentamerus limestones, in the upper part, furnish a gray, heavy-bedded and strong stone, which answer for heavy masonry. Quarries in the Lower Helderberg group are opened in the Schoharie valley at Cobleskill, Cherry Valley and in Springfield, Otsego county.

The quarries near Hudson, in Becraft's mountain and the quarries near Catskill also are in it.

Upper Helderberg Group.

Under this head there are building stones in the several limestone formations. Of these the principal are the Onondaga and Corniferous and the Seneca blue limestones. The noted "Onondaga gray limestone," of Onondaga county, belongs in this group. The Union Springs, Waterloo, Seneca Falls, Auburn, Le Roy, Williamsville and Buffalo quarries are Upper Helderberg. The Kingston, Ulster county, limestone also belongs here.

There is a great diversity in the limestones which are quarried in these localities and from this geological group. The Onondaga gray limestone is coarse-crystalline, and contains coralline fossils; and makes a beautiful stone for fine cut ashlar work or for ornamental and decorative uses. The cherty or corniferous beds are dark-colored, hard, and do not dress well, and answer for common work only. The Seneca blue limestone dresses well and is a fairly good building stone.

As a supplement to the limestones the quarry in calcareous tufa at Mohawk, in the Mohawk valley, should here be mentioned, although the quarry is of no importance and there is no great outcrop for much work in it.

It is proper to refer to the division of Fragmental Rocks, the stone which occur in the Quaternary formation, particularly and chiefly in the Glacial Drift. This drift is found in all the counties of the State and in nearly all of the towns, overlying the older rocks. But it is unimportant as a source of building stone at the present time. In the earlier history of the country many stone buildings were constructed

of the stone found lying on the surface or in the surface earth. They are sometimes called "field stone." Having been transported many miles and been subjected to great wear, they represent the more resisting and harder rocks. They are generally more or less rounded and scratched or furrowed. Geologically they are known as *boulders.* On Long Island they are the only stone to be had. And some of the older houses on the western end of the island are built of sandstone obtained from the drift. Others are of sandstone, trap-rock and gneissic rock, mixed. In grading and cutting down the hills in Brooklyn enough stone is sometimes found to lay the foundation walls. Of course the drift includes the harder sandstones, quartzites and gneisses mainly.* At Medina, in uncovering the sandstone transported blocks occur in the stripping or drift. But this formation cannot be considered as a source of any regular quarry business, though, in the further clearing up of the country, it may yield a great deal of stone for the localities where it occurs.

Slates.

Slate is used to designate compact, fine-grained rocks, which have the property of cleaving into thin plates. The term rests for its signification upon a physical property rather than upon chemical or mineralogical composition. Hence there are many varieties from the argillaceous (clay-slate, or *argillyte*), to hornblendic, chloritic and hydromica slates or schists. But nearly all of the slate which is employed either as constructive or as decorative material belongs to the argillaceous variety, *clay-slate.* It is a sedimentary rock and occurs associated generally with sandstones and other fragmental rocks. Since the great use is for roofing material, it is often called *roofing slate.* The prevailing colors are gray to blue-black; purple, red, green and variegated (red and green), are less common shades. There is much variation in the degree of hardness, and some are very hard and also brittle. The fineness of grain, or texture is another mark of difference in slates. Generally the rock which is more highly metamorphosed, is stronger and more fissile, and hence a more durable material. The direction of the cleavage may coincide with that of the dip of the bedding planes, or it may be oblique to them. For use as roofing material, the color, fineness of grain, strength, hardness, freedom from pyrite or seams of calcite and quartz, and durability are essential qualities.

* At Yonkers the trap-rock boulders have been used largely in the building of retaining walls and foundations.

The Hudson River group in New York, is characteristically a slate formation. It occupies the Wallkill valley in Orange county, the valley of the Hudson river from the Highlands northward to Saratoga and Washington counties, and the Mohawk valley west, and thence a belt north-west to Lake Ontario. Slates of the Cambrian age are recognized east of the Hudson in Washington and Rensselaer counties, near the Vermont line. It is not known that any of the *slaty* rocks of the other geological formations in the State yield slate of economic importance. Roofing slate has been sought after in very many places within the bounds of these formations and quarries, which have been more or less productive, have been opened in Orange, Dutchess, Columbia, Rensselaer and Washington counties.* At present, the productive quarries are all in Washington county, and are limited to a narrow belt which runs from Salem north-north-east, through the towns of Hebron, Granville, Hampton and Whitehall. There appear to be four ranges or belts ("*veins*" of quarrymen) first, on the west, the East Whitehall red slate; second, the Mettowee or North Bend red slates; third, the purple, green and variegated slates of Middle Granville, and on the east, near the Vermont line, the Granville red slates. These quarries of Washington county produce a large amount of colored slate for decorative and ornamental work, and all the red slate which is quarried in our country, comes from this district.†

* See MATHER'S REPORT on the First District, pp. 419, 421.

† The line between Vermont and New York runs so as to separate the red and sea-green slates, and all of the former are in New York, while all of the latter are in Vermont.

DESCRIPTIVE NOTES

— OF —

Quarry Districts and Quarries.

I.—CRYSTALLINE ROCKS.

GRANITES, SYENITES, GNEISSES, MICA SCHIST.

Beginning at the south, with the quarries in rocks of this group, the NEW YORK or MANHATTAN ISLAND gneisses have afforded a large amount of stone for common building work. These gneisses are mostly of the micaceous variety; and they are found in thin beds, dipping at high angles generally and to the east-south-east or west-north-west. Owing to the large percentage of mica they are not so strong and durable as the true gneisses and granite; and are apt to flake off and disintegrate on long exposure. Some of the more feldspathic beds and the granitic veins and dikes afford a stronger and better material. But the general mass is at best of an inferior character. The excavations for streets and the grading of hills has yielded a very large amount of stone for foundations and inner walls. The Forty-second street reservoir is an example of the best of the island gneiss. St. Matthews's Lutheran Church, Broome street, is another.

FORDHAM, WESTCHESTER COUNTY.—St. John's College has a quarry on its property nearly a half mile east of the college, and on the corner of the Boulevard and Pelham avenue. There are two openings, of which the larger, measures, approximately 140 feet by 50 feet and 25 feet deep. The strata dip 82° to 86° S. 65° E. The stone is a micaceous gneiss, consisting of brown-black mica in laminæ, parallel with the bedding and alternating with quartz and feldspar. It has a bluish-gray shade of color, and hence is known as "blue-stone." Owing to the mica the stone splits readily in planes parallel to the bedding, and is squared easily into blocks for heavy walls. And blocks 25 feet long, 6 feet wide can here be obtained. There is no water

to be raised, and the quarry is worked to advantage on account of the little *stripping* and the ease with which the rock can be split. The two new buildings of the college are built of this "bluestone," dressed and laid in course work.

Another quarry in the micaceous gneiss is seen at the south side of Pelham avenue, near the College quarry, but it is small and not worked to any extent.

HARTSDALE, WESTCHESTER COUNTY.—Near Hartsdale station, on the Harlem railroad, a gneiss rock is quarried for the local market. It has been used at White Plains in the court-house and jail buildings, and in the bank building near the court-house, and also in a church. The stone is substantial and durable, but rather unsightly, on account of some of the weathered, rusty, reddish-brown blocks, due to iron stains.

Gneiss rock is quarried south-east of White Plains; and it can be seen in the Methodist Episcopal church on the main street. It does not show the same iron stains as the Hartsdale rock.

SCARSDALE, WESTCHESTER COUNTY.—Several openings, which are known as the Seely quarries, are to the west of the road to Greenville and on the ridge, a half a mile west-north-west of the Scarsdale railroad station. The main opening is at the south-east and near the corner of the road. It is about 80 x 25 feet and 5 to 18 feet deep. The rock is gneiss, thick-bedded and grayish in color. The strata dip 72° north, 57° west. The smaller openings are west and north-west of the main one, and between them the same massive bed of rock is exposed and having the same dip of its strata. The principal minerals of the rock are quartz, feldspar and a little black mica, and these minerals in parallel lines and layers give the gneiss a foliated structure. The exposed ledges near the quarry show very little alteration due to weathering; and are firm and solid, indicating a strong and durable stone. Blocks of large size, up to 40 feet in length and 15 feet wide, have been taken out. The plant consists of one engine, one derrick and two steam drills. There is no water. Stone from this quarry has been used for bridge work for the Bronx River aqueduct, and also for the Williamsbridge Reservoir gate-house. The stone seems specially adapted for heavy work. The quarry is worked at intervals according to the demand, and the stone carted by team to the railroad station.

HASTINGS, WESTCHESTER COUNTY.—Gneiss rock has been quarried on the river bluff, one mile south of the railroad station at Hastings. The bluff has been worked back to an height of 40 feet and a length of 250 feet. The strata dip 75°, in an east-south-east direction. One system of joints runs with the strike, north 35° east and dips about 15° to the north-west. A second system runs south-east and is vertical. A third system runs in a south-easterly direction also, but dips at a moderate angle to the south-west. The beds at the south end are thick, and stone of large size can easily be obtained. The more westerly beds, which are at the north end of the quarry, are more schistose and thin. The stone is hard to cut, but splits straight in the planes of the beds. The thick beds afford large blocks for bridge work. The thin strata are worked up into common wall stone and foundations, and these latter are quarried by individuals at intervals. The quarry is owned and worked by the New York Central Railroad Company, but is not constantly in operation.

HASTINGS.—What is known as "*Munson's quarry*," is three-quarters of a mile east-south-east of Hastings. It is the property of Wm. G. Lefurgy. And it was first opened in 1850. The opening is at the south-west end of a high, rocky ridge of micaceous gneiss, whose beds dip at an angle of 70° to the south-east. It runs about 300 feet into the hill, and has an average width of 100 feet. The bedding is very regular and even, and the beds are nearly all thin. The rock is a biotite gneiss, which has a gray and striped appearance, due to alternate, thin layers of black mica and thicker layers of feldspar and quartz. It is fine crystalline. It is readily split in planes parallel to the bedding or broken crosswise, if not shattered by blasting. There is no water to be pumped, and there is no machinery other than a hoisting crane. The stone is carted to the river. The larger stone is shipped to New York city for foundation walls; the smaller blocks are used for common walls; and some is cut into curbing. The glaciated, outcropping ledges at the north of the quarry show little signs of weathering. From five to fifteen men are employed steadily in the quarry.

J. N. Ferguson's quarry is on the same ridge, and about 80 rods to the north-east. It has been opened three years. The beds dip at an angle of 70° to the south-east. The stone resembles that of Lefurgy's quarry. The beds are from 6 to 12 inches thick. And the adjacent outcrops are a proof of the durability of the stone

when exposed to the weather. The stone is carted by teams to the dock at Hastings, whence it is shipped for foundations and building generally.

YONKERS.—Valentine quarry. This old quarry consists of two small open cuts on ledges, which crop out in front of the Valentine house, on the top of the hill, two miles south-east of Yonkers and on the Mount Vernon road. The openings are only a few rods long, and not over 12 feet in depth, and about 20 yards wide. The strata stand on edge and their strike is north 55° east. The stone of this quarry is a grayish-black, striped mass. The quarry has not been worked of late years.

TARRYTOWN.—The old Beekman quarry is on lands of A. C. Kingsland, one and a quarter miles north of Tarrytown, and at the east side of the railroad track. It was worked largely in former years; latterly, the quarrying of some stone for building walls is all that is done. The quarry has a length of about 800 feet; a breadth of 80 to 160 feet, and, at the back, is 50 feet deep. The strata dip 55° to 80° south, 65° east. There is much variation in the rock. Some of it, at the north end, is schistose and thin-bedded. The stone, which is quarried, is a massive-bedded, granitoid gneiss, gray to flesh-colored; and hard and compact, although easily dressed. Blocks of large size can be obtained. Being above the tide level and conveniently located on railroad and river, this quarry has advantages for working.

KENSICO, WESTCHESTER COUNTY.—On the east side of the Bronx River reservoir at Kensico, north-east of the dam, and a quarter of a mile from the station, gneiss has been quarried extensively for the construction of the reservoir dam and for local use. The opening at the side of the reservoir has a face 50 feet high and a total length of 600 feet from north to south. The beds dip 30° to 40° north, 60° west. The stone is a granitoid gneiss, in thick beds, of gray color. Back of it and lying upon it are thin beds of schistose rock, which is valueless as building stone. There are two main systems of joints; one runs north 45° west, and the other north 65° west. A third system of joints dips about 40° east-south-east, and runs nearly in the course of the strike of the beds, *i. e.*, north 30° east. These seams or joints break the mass into blocks of large size. The disadvantage at this quarry seems to be that the thick bedded gneiss is confined to a narrow belt in the more micaceous and schistose rock.

UNION VALLEY, PUTNAM COUNTY.—The quarry of Jackson & E. Ganung. These quarries are four miles, by the road, from the town of Croton Falls, and a half a mile south of Union Valley, in the town of Carmel. They are small. The beds dip 75° to the north-west. A prominent joint system runs east and west, dipping about 80° north ; somewhat wavy in its course. The stone has a striped appearance, due to black mica and white feldspar alternating in thin layers, from one-eighth to half an inch thick. The main use of this stone is for posts and foundations. Some of it has been used for monuments and a little for buildings also. A good example of it can be seen in the house of Mr. Todd, one mile south-west of Croton Falls. The quarries are worked irregularly and for local market. The stone is durable, as shown by the weathered ledges in the quarry, but it is not capable of being polished, and when dressed and rubbed it has a wavy and striped appearance, which is not altogether pleasing to the eye.

RAMAPO, ROCKLAND COUNTY.—A gneissic rock is quarried south of Ramapo village on lands of Henry L. Pierson. The quarry is in the steep face of a low ridge — and about fifty rods west of the line of the N. Y. L. E. & W. R. R. The hill side has been worked to a height of nearly one hundred feet above the valley level at the east. The rock is a syenite gneiss or hornblendic granite and is so massive-bedded that the stratification is not plain. A well-marked joint system has a course of few degrees north of west and dips steeply southward. A second system of joints runs vertically, south. The stone is red flesh-colored. It splits *true* and is not difficult to dress for heavy, squared masonry, for which it is specially suited on account of its strength, durability and the large size of blocks which can be obtained. The quarrying is scarcely more than the throwing off by large blasts of great masses of the stone which are subsequently broken up into desired sizes. A little of this stone has been used for monumental work. The stone for the Hon. Abram S. Hewitt's house, at Ringwood, N. J.; and for some of the Erie railroad bridges is said to have come from this quarry. The place is easily worked, as there is no water, and no hoisting as from a quarry in excavating, and it is convenient to railway.

Over the hill to the west, and near the New Jersey line a granite quarry has been opened by John L. Rowland, and a little stone taken out. Blocks of large size can here be obtained, but owing to the hilly road and the distance it is not worked to any extent.

SUFFERN, ROCKLAND COUNTY.— Granite for cemetery posts and for monumental bases has been quarried for years past from the side of the ledges a quarter of a mile west of Suffern station and at the side of the Ramapo road. The stone is greenish-gray in color, but weathers to a reddish-brown cast. It is hard to cut and dress, but is durable. A very little of it is used by Wm. Copeland, at Suffern, for cemetery work.

PEEKSKILL.—Hudson River Granite Company's quarry. This company is opening a granite quarry on a rocky ledge about two miles north-west of Peekskill and east-north-east of Iona island. It is on the land of the Van Cortlandt estate. The entire point, which is pierced by a railroad tunnel, is almost bare of soil and earth; and an immense mass of solid rock is in sight. Its slightly weathered surface indicates the durability of the stone, and the absence of bedding planes will enable the quarrymen to get out large blocks. The stone is gray — flesh-colored, medium fine-crystalline and consists of feldspar, quartz and hornblende. The parallelism in the arrangement of the minerals shows the *grain* of the stone to dip steeply, east-south-east. A track has been built from the quarry, down on the slope of the hill to the river, where there is a dock. The chief product is to be paving blocks.

WEST POINT.—West of the academy buildings and on the side of the hill gneiss rock has been uncovered and quarried for the construction of the Government buildings. The most southern quarry is south-south-west of the Observatory, and a quarter of a mile from it. The rock is a biotite gneiss. It dips 40° to 50° S. 75° E. The opening is 100 feet long, 40 feet wide and about 18 feet deep. A second opening is 150 yards north-west and is 150 feet by 75 and 15 feet deep. The rock here is rather more massive-bedded and gray in color. The beds dip 38° E. SE. North of Fort Putnam and west of the Academy there are three almost connected openings, and within 200 feet of the road. The bedding of these quarries is not so plain as in the more southern openings. The dip is 25 to 30° E. SE., and the rock shows a pitch to the NE. at an angle of 25°. The rock is fine-crystalline and hard; and the ledges about these openings are a proof of the durability of the stone. North of the last described locality is an older quarry, and about 100 feet west of the road and a half a mile north-west of the Academy. Its extent, from east to west, is about forty yards, north to south thirty yards, and it

is ten to twenty-five feet deep. The dip is 20 to 25° S., 70° E. One system of joints runs vertically SE.; a second S. 70° E. and dipping 75° S. SW. The rock is a hard, solid, thick-bedded, granitoid gneiss, with little mica. The firm outcropping ledges about these quarries show the durability of the stone where exposed to the weather. The library building, and the old riding academy, and three of the professorial residences, as well as long lines of retaining walls, are constructed of the native rock from these quarries. The quarries and these examples of the use of gneiss in the Highlands are instructive and suggestive of other localities for opening such stone, and for its use where strength and solidity are wanted.

STORM-KING MOUNTAIN QUARRY.—Granite has been quarried from the south-east face of Storm-King mountain, near the West Shore railroad track,. and a half a mile south of Cornwall station. The property is owned by M. C. Lawrie of New York. Great masses of rock have been thrown down by blasting, and subsequently broken up for building stone and into paving blocks. This stone has been used in buildings in New York city, and also in Washington, D. C. The cliff is about 100 feet in vertical height above the railroad track. The location is convenient to both the railroad and the water, and there is no pumping or hoisting as is necessary in the excavation from a quarry. The stone is a gray, moderately coarse-crystalline mixture of feldspar, quartz and a little mica. Its durability is attested by the scarcely weathered surfaces of the exposed ledges of the face. The locality has not been worked for several years.

BREAKNECK MOUNTAIN QUARRY.—Granite has been quarried at several points on the south side of this mountain and north of Cold Spring. It is at least sixty years since the locality began to be worked. And at long intervals quarrying has been carried on up to the present time. These quarry sites extend back nearly a mile from the river. The work has been to detach blocks of large size by blasts, and then to break them up into convenient sizes for building stone or into paving blocks. The present quarry is on lands of Lewis J. Bailey, and is worked for both building and paving stone, the latter by William V. Smith of New York. And a crusher breaks stone for roads. The quarry is at the east side of the railroad, and extends up the mountain side to a height of 500 feet. The stone are shipped by boats at dock on the property. The stone is a gray to gray-white, coarse-crystalline hornblendic granite.

LITTLE FALLS.—Gneiss, or, as it is here known, the "blue rock," has been used a great deal in Little Falls, on account of its numerous outcrops and the necessary openings in it for the construction of the Erie canal, the New York Central railroad, and the excavations for buildings. No regular quarries have been opened; nor is it exported for construction elsewhere. The rock has a greenish-gray shade, and is moderately fine-crystalline in texture. It is hard and a durable building stone, as can be seen by the ledges outcropping in the valley and in the old structures and walls built of it. The stone was used in several mill buildings, in the R. C. church, in the new school, in the Presbyterian church and other buildings in the town.

WILTON, SARATOGA COUNTY.—Granite is quarried in the town of Wilton, two miles north of Saratoga, on the eastern slope of a gneiss rock ridge, and about 80 feet above the plain. The opening is in the face of a south sloping ledge which rises 100 feet or so above the quarry. The beds are thick and dip about 40° south-south-west. The rock is divided by a joint system, which runs north-north-east, and dips steeply east-south-east. The bed which is now worked is about 15 feet thick. The opening has a breadth of about 100 feet and is about 60 feet deep. The plant of the quarry consists of one derrick, and a shed for dressing. The stone is light gray in color, and is plainly stratified; and in places shows lines of black mica which are in sharp contrast with the white quartz and feldspar; and it is rather fine and crystalline. Some red garnet is present in small nodular masses. The stone can be split with the *rift* or grain of the mass. It is hard, but dresses *true* and readily. The weathered ledges all about the quarry show that it is very slightly affected by long exposure. One objection to this stone for building purposes is the garnet which gives the mass a brown, and in some cases a spotted appearance, which is not pleasing. Very little of it has been used as building stone. The greater part of the product has gone into paving blocks, some of which have been laid in Albany, some in Cohoes and other places. The quarry is one mile from the D. & H. C. Co.'s railroad station, and the stone is shipped over that line. The quarry is worked by A. N. Brady, of Albany.

North-west of the Wilton quarry granite has been worked in the town of Greenfield, but only to a limited extent. The quarries are now idle.

Granite has been quarried at the side of the Adirondack railway near Wolf Creek or Quarry Switch, as the place is now known. The

property is owned by George Marks, of West Troy. The opening is a few rods west of the railroad line and a little way up on the point of the ridge. The stone is properly a gneiss rock. It was worked for a time, and some of the stone was sent to Albany for the new capitol foundation.

ADIRONDACK GRANITE COMPANY, WESTPORT, ESSEX COUNTY.—A granite quarry was opened in 1881 on the shore of Lake Champlain and on the Splitrock tract, by the Champlain Granite and Marble Company. Very little work was done that year. The locality was reopened in 1887 by the present company. The quarry is reported to be one-third of a mile from the wharf in Barron Rock bay and at an elevation of 500 to 600 feet above the lake. The specimens submitted to Prof. Hall in 1881, were reported by him to contain labradorite, hornblende, quartz and a small proportion of dark-brown mica.* The stone is said to receive a good polish, and a monument in the Middlebury, Vermont, cemetery shows that it retains the polish. The quarry is two and a half miles from the line of the D. & H. C. Co.'s N. Y. & Canada railroad.

AU SABLE GRANITE, ESSEX COUNTY.—The quarries of the Au Sable Granite Company are on the north slope of Prospect Hill, one and a half miles south of Keeseville, and in Essex county. There are two openings, a little more than 100 yards apart. They were made in ledges whose surfaces were glaciated. The lower quarry is to the northward, and has a maximum depth of 20 feet. The joints which appear in the rock at this place are smooth and irregular. One runs south 55° west. The others are not so regular. Another system of joints runs south 10° east. The rock at this quarry is coarser in crystallization than that of the upper quarry. The mineral composition is labradorite, hornblende, quartz and here and there a scale of brown mica. The weathered rock has a light-gray shade, due to the alteration of the feldspar in the long ages since the close of the glacial epoch.

The upper quarry is about twenty rods south 10° west of the lower, and is at least 100 feet higher up on the hill. The original surface was steeply sloping north-west, and the earth covering was thin. One main set of joints is vertical, and runs south 40° west. A second one dips in the same direction. A third has a south-easterly

*Report to company in their circular.

course, and dips steeply north-east. These joints or seams are usually from four to six feet apart, hence the blocks as made by these joints are large. This subdivision of the rock facilitates the quarrying of large masses, which are afterward broken into sizes by means of plug and feather wedges; and very little powder is used, as there is no blasting except to throw off the surface stone. The joints also help in the working into the hillside east and south and upward.

As the quarries are on the side of the hill, and are not yet deep, there is need of very little pumping. There is one derrick for hoisting stone at the lower quarry and one at the upper quarry. At the upper quarry a track runs from the quarry to the dump where the waste rock is thrown out. All of this stone on the dump would answer for ordinary building purposes, but owing to the lack of a local market it is practically useless.

The glaciated ledges, with their rounded, grooved and polished surfaces, near the quarries on this side of the hill, both above and below them, show very little alteration by exposure to the weather; and the durability of the stone is proven by the very slight tendency to alteration in these surface outcrops. The quantity of stone is apparently unlimited. The distance to the railroad or lake at Port Kent, which is the nearest point to rail or boat, is the only serious drawback, as all of the stone has to be hauled by teams to that point or Douglass station. The company has its dressing and monumental works in Keeseville, and the product goes into market, dressed. On account of its hardness and the cost of dressing, the Au Sable granite cannot compete with limestones or sandstones for common wall work, but for decorative or monumental work it is especially adapted, because of the high polish which it receives and its beauty. The dark, polished surface, with its chatoyant play of colors, is both beautiful and pleasing, in contrast with the substantial-looking, gray, dressed surfaces. And lettered work is thus sharply defined in the dark ground.

This granite has been used for interior decoration in a church in Philadelphia. It is being put into the trimmings of the Y. M. C. A. building at Burlington, Vermont. For monuments it has had a wide market.

Another quarry is opened in the granite on this (Prospect) hill, about a quarter of a mile south-west of the Au Sable Granite Company's openings. It is idle.

One mile west of Keeseville, Clinton county, the granite has been opened by a Glens Falls party.

GRINDSTONE ISLAND, JEFFERSON COUNTY.—A red granite is quarried extensively on this island in the St. Lawrence river, north-west of Clayton. There are many outcrops, especially on the western side of the island, and small quarries have been opened at more than twenty different points. Three of them are large and worthy of notice here.

GORDON'S QUARRY is about a half a mile from the north-west side of the island. There are two openings, at the east and west ends respectively, of a low, rocky ledge, which rises twenty feet above the surrounding surface and sixty feet above the river. On the west paving blocks are made; on the east a large part of the stone goes into buildings. The vertical joints run nearly north and south, and are used in blasting apart the great blocks of stone. Afterwards these blocks are split by plug and feather wedges. As the stone splits *true*, and blocks of large, rectangular shapes are readily got, it makes an excellent heavy-wall stone. And it is used for massive foundation work. The stone is red and coarse-crystalline. It is worked for the International Granite Company of Montreal. The stone are shipped by boat down the St. Lawrence.

THE CHICAGO GRANITE COMPANY'S QUARRY is on a north-west facing hill side, about 1,000 feet from the bay and river, and in a great rounded ledge of rock. The excavation has a length of 100 yards from north to south, and at the most is not more than forty feet in depth. It is all above natural drainage. The seams or joints, dividing the rock, appear to be irregular and not continuous. The stone splits most readily in planes which dip to the eastward. It is red, mostly coarse-crystalline, but varies in texture from point to point. Imbedded and rudely spheroidal masses of a gray, granitoid rock, of much finer grain, occur in the red granite, and are here known as "knots." This quarry has been opened for five years. The output has been nearly all in the form of paving blocks, and has been sold to western cities. A tramway, 1,000 feet long, connects the quarry with the wharf, at which there is a mean depth of twelve feet of water.

THE THOUSAND ISLAND GRANITE COMPANY'S QUARRY is on the point of a rocky promontory which projects north-west into the river, and is on the northwest side of the island. It is at least a quarter of a mile east of the Chicago company's quarry, and is in a rocky knob,

which was originally bare, and at an elevation of sixty-two feet above the river. Vertical joints traverse the rock in two directions; north 35° west, and north 35° east. The first are known as "headers," and the latter as "grain seams." And the rock splits more readily in lines or planes parallel to the latter. The stone is coarse-crystalline, bright red in color, very hard and strong.* Its mineral constituents are feldspar, quartz, brown-black mica, hornblende and some calcite. Scattering crystals of pyrite are seen in places, with hornblende. "Knots" of the red-gray, gneissic rock, occur here also, imbedded in the red, coarse-crystalline matrix. Its durability is witnessed by the unaltered or scarcely altered rock, which is exposed on all sides of this rocky promontory. It breaks readily into sizes for paving blocks. In the process of quarrying the practice is to put in deep holes, and with a large blast throw out great masses of rock, which are then worked up into building stone and paving blocks. Blocks twenty feet long, six by six feet, are readily obtained. In fact, the limit in size is the shipping capacity and the means for handling. Three quarry derricks and one loading derrick are worked by steam. Tracks run from the quarries to the dressing levels, and then to the dock. There is eighteen feet depth of water at the dock. The greater part of the product of this quarry is shipped to western cities, principally Cincinnati and Chicago; and mostly for paving streets.† A great deal is shipped to Montreal for monumental work and for building stone. The price ranges from $1.00 to $2.00 per cubic foot, in sizes under 20 cubic feet. The waste is used at Montreal for granulyte pavement. The stone from this quarry can be seen in the columns in the Senate chamber of the new capitol at Albany. They were quarried at the end of the bluff, and not far from the original surface. At present the workings are deeper, and the stone is better. This quarry has been opened seven years. The granite is apparently inexhaustible.

All of the stone from these quarries on Grindstone island is shipped by boat to Chicago, Toledo, Montreal or other points of destination.

MARBLES.

NEW YORK CITY.—The white limestone was quarried for marble on Manhattan island near Kingsbridge, and used in the construction

* The resemblance to the Scotch granite, has given the name of "International Scotch granite" to this stone.

† One million paving blocks were sold last year (1887). And 100 to 120 men are employed all the year.

of buildings, but nothing has been done there for a long time. The stone is impure and somewhat crumbly on surface ledges, and is not a good marble.

At Morrisania some stone has been quarried for bridge construction; also at Mott Haven, both in the white or yellow-white crystalline limestone, but they cannot be called marbles in a proper sense.

AT TREMONT (WESTCHESTER COUNTY), St. John's College owns a marble quarry on Third avenue. The dip of the strata is 66° to 70° S., 60° E. One prominent joint system runs N. 20° W. and dips 80° S. 70° W. A second system dips a few degrees northwest. The stone is a white, crystalline marble, and was used in trimmings for St. John's College. Its contrast in color with the dark-blue gneiss in the college buildings is striking and effective. This quarry is worked for the college work, and not for the public market.

A white marble was formerly quarried on the east side of Washington avenue, and near One Hundred and Seventy-eighth street and Tremont. The strata here dips 80° S., 55° E. The opening is only about 100 feet long, 50 feet wide and 15 feet deep.

The quarry of Caleb Hillman is on the south side of East One Hundred and Seventy-eighth street, between Third and Madison avenues. The rock has been opened for a length of 200 feet on the strike of the beds and about 60 feet in width. The dip here is 80° S., 57° E. The opening is not over 10 feet deep. The stone obtained is white and fine-crystalline. Some of the bed faces show a little yellowish mica, and in some parts of the beds a white tremolite is observed. The quarry was opened thirty years ago.

North of this quarry of Hillman's a few rods is another and older opening which is 200 feet long by about 15 feet in depth, running from One Hundred and Seventy-ninth street southward. This latter quarry is not now worked. Hillman sells marble for steps, lintels, etc., and for house trimmings. There is no water and no machinery is used.

These marble quarries in Tremont are worked irregularly as the demand calls for the stone, and the output in the aggregate is comparatively small and unimportant.

TUCKAHOE, WESTCHESTER COUNTY.—The marble quarries at Tuckahoe are opened in a depression or narrow valley at the eastern foot

of a low ridge and east of the Harlem railroad. They are in a line from north-north-east to south-south-west, and between a quarter of a mile and one mile from the Tuckahoe railroad station. The crystalline limestone makes a narrow belt between the mica schists which bound it on the west and on the east sides. And its beds appear to be conformable with the schistose strata.

The north-eastern quarry is on land of the Stewart estate. The quarry was partly filled with water when visited, and the outcropping strata and upper part of the walls alone were then seen. The dip of the beds is 70° N. 60° W. The stone is white to bluish-white, coarse-crystalline, and contains some scattering, small scales of white mica. On the joint faces tremolite crystals are common. This quarry has been idle for twenty years, and the mill at the south side of the quarry is in ruins. The marble in the Stewart mansion, Fifth avenue and Thirty-fourth street, New York, was got here.

About 100 rods south-west of Stewart's quarry is that of ——— Youngs, which is 200 yards long on a line with the strike, and 100 feet wide, opposite the mill, and 30 feet wide at the south end and 40 feet deep. The beds dip 75° N. 55° to 60° W. The stone is white, and rather coarser-crystalline than that of the Stewart quarry. The association of the marble and the foliated, schistose gneiss on the west side of the quarry is interesting, and the two rocks are seen almost in contact and have the same regular dip to the west-north-west. At the west side of the quarry there is a substantial marble mill with six gangs of saws, and two large derricks stand on the same side of the quarry. This quarry was idle the last year.

The New York Quarry Company (J. M. Masterton) owns the next quarry to the south. And it the largest of the Tuckahoe quarries. When visited a part of it was filled to a depth of 60 feet with water, and above it the sides were about 60 feet high on the west and 20 feet at the east. The rock here has a dip of 70° west-north-west, and it is traversed by two systems of joints, of which one crosses the quarry, dipping 80° north, and the other rolls to the south-east, with an average dip of 30°. The stone is coarse-crystalline and pure white. On the east side of the quarry the mill, engine-house and five derricks are placed. Two lime kilns at the south end, burn the spalls and the stone not used for building, into lime. The ridge of mica schist at the west has its beds in conformity with the beds of crystalline limestone at the west border of the quarry. The Tuckahoe quarries were first opened about 1820. And buildings

erected sixty years ago show the excellent quality of this marble. Although so much has been taken out, the belt of stone is by no means exhausted.* And with a revival in the marble trade these quarries could meet a large demand. When worked in 1873 the Masterton quarry is reported to have produced 200,000 cubic feet of marble. Formerly the stone was carted direct by teams to tidewater on the Harlem river. Latterly shipments have been by rail. And all are convenient to railroad. Blocks 27 feet by 4½ feet by 2½ feet have been dressed and put in the U. S. Custom-house at New Orleans. The U. S. Post-office at Washington, the U. S. Treasury building in New York, the City Hall in Brooklyn, are public buildings constructed of Tuckahoe marble. Besides these there are in New York city the Mutual Life Insurance building, the Fourth National Bank, the Park Bank, Herald building, Manhattan Life Insurance building, Stewart mansion, Ninth National Bank building, Arnold block on Broadway. In Boston there are the Sears building, Vendome Hotel, Revere Bank, Montgomery building, and many others.

THE BATES MARBLE QUARRY.—This quarry is situated a half a mile south-east of the Scarsdale railroad station, and in the south end of a low ridge of limestone. It is about 120 yards long by 50 yards wide. The strata dip 45° N. 20° W. On the surface the outcrops of the white limestone or marble are weathered and the stone is friable. The quarry has not been worked in some years and is partially filled with water.

THE SNOW-FLAKE MARBLE QUARRY.—This quarry is one mile south-east of Pleasantville in Westchester county. It is known as the Snow-Flake Marble Company's quarry, of which A. L. Pritchard is the manager. The place has been opened as a quarry about thirty-five years. The opening has a length of about 500 feet from south-west to north-east. The extreme breadth does not exceed 400 feet. The covering of earth on the rock varies from a thin soil to 10 feet deep, but the *stripping* is thicker as the upper beds and some of the top rock is worthless. There is very little water, and that which accumulates is siphoned out into the adjoining Cornell quarry. Formerly the stone was cut by channelling machine, and worked up in the mill, which is located near the quarry. At the present time the

*These quarries are in the town of Eastchester and they are described in Mather's Report on the First District as "Eastchester Marble Quarry."—*See Mather's Report*, page 454.

practice is to blast down great masses of rock, which are broken up into suitable blocks for building stone, and which are sent into the market rough dressed. The mill has not been worked for the past two years. This marble is white and very coarse-crystalline ; hence its name. It is somewhat harder than the Vermont marble and does not compete with the latter for monumental work. It was used in the St. Patrick's Roman Catholic cathedral, Fifth avenue, and in the front of the Union Dime Savings Bank building, Sixth avenue and Thirty-second street, New York city ; also in the M. E. church in Sing Sing.

HASTINGS, WESTCHESTER COUNTY.—The marble quarry on the bank of the Hudson, south of the Hudson River Railroad station, has been idle for a long time. The stone is a dolomitic limestone, white, and rather fine-crystalline.

SING SING.—A large quarry in the crystalline limestone, east of the prison and on the State property, was formerly worked for marble. The workings extend for a quarter of a mile from north-east to south-west, but the stone now raised is burned into lime. The old (marble) quarry is higher and nearer the surface than the present quarry floor. And the stone which is now taken out is, apparently, more durable and stronger than much of the marble. Some of it has a yellow-white shade, but the mass is white. In texture it is fine-crystalline.

This old quarry is famous for the buildings which have been constructed of its stone. The State prison buildings here and the State Hall at Albany are examples.*

AT SPARTA, south of Sing Sing, marble is quarried by a New York city firm. The opening is at the east side of the main road and is about 200 feet long, north and south, and varies from 60 feet to 90 feet in width. The extreme depth is 40 feet. The beds dip 55° east-south-east. The marble has a yellowish-white shade of color, and is fine-crystalline. The outcropping ledges at the side of the quarry show that the surface rock is friable and crumbles readily to a sandy mass. The stone at the bottom is solid and apparently more durable.

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* It is interesting here to refer to a statement made by Mather in his Report on the First District, p. 455, in which he says that "many blocks of this rock were brought to Albany for the construction of the new State Hall, that were already crumbling; but whether they were put in the structure, or rejected by the builders, as they ought to have been, I do not know." Probably not, as we know the structure!

The white limestone in the DOVER PLAINS-PATTERSON VALLEY, has been worked at several points near Dover Plains, South Dover and Patterson for marble. The first quarry was opened on the Ketcham farm on Dover Plains, and near the foot of the East Mountain. It has been idle many years. Another quarry is on lands of Horace D. Hufcutt, and on the eastern side of the valley. The stone is white to bluish-white and rather fine-crystalline, and dresses easily. A plainly marked set of joints traverses the rock, dipping 75° north. The quarry is small, and but little stone has been taken out of it of late years.

The quarry of Geo. W. Ketcham is on the east side of the road, two and a quarter miles from Dover Plains. The strata here have been opened for a length of 300 yards on a line with the strike, S. 5° to 8° W., and for an average breadth of 70 feet and a depth of 25 to 50 feet. The strata dip 85° to 90° S. 82° to 85° E. One vertical joint system runs east and west, dipping steeply south. A second system is nearly horizontal, dipping a few degrees westward. There are two varieties of stone in this quarry, white and blue; but these varieties are apparently intermixed without order, sometimes in the same bed. About thirty feet of the stone is above the natural drainage. This quarry was opened by Mr. Ketcham in 1840 and was in operation up to 1883, since which time it has been idle. It was worked extensively, and for a time the annual output amounted to 40,000 square feet of stone. The whole went into monumental work.

Near South Dover marble was formerly quarried on a large scale at the Preston and McMichael quarries. The Preston quarries are two miles north-east of South Dover railroad station. The western opening is about half way up on the western slope of a long, low ledge of white limestone. The strata dip 60° westward. The beds are thick. The stone is white, containing more or less scales of white mica, scattered through it and is rather coarse-crystalline. The weathered or exposed ledges of this ridge appear quite solid and not much disintegrated. In the quarry the top stone is soft and crumbly. The eastern opening is on the east side of the ridge; it is about 375 feet long and 100 feet wide. The quarry face is 30 feet high. The dip is westward. A very marked set of joints dips 30° eastward. The quarry has not been worked in years, and the marble mill has been used for a tobacco drying-house.

There is a marble quarry, one mile south-east of Pawling, on the Patterson road, which has been idle for many years.

At Towner's Four Corners, in Putnam county, marble is quarried for common walls and foundations.

The marble quarries in the town of Dover were worked vigorously about forty years ago: the product was grave-stones mainly. The quarries are shallow excavations, and unlike the deep, underground quarries in Vermont. And the stone from these upper beds is probably not as solid and compact as that from deeper workings would be, nor as free from seams. Old analyses show it to be a dolomitic stone. But what portions may be less magnesian or even pure limestone is not known. Generally the stone is fine-grained, and much of it from the surface crumbles down to a granular mass on long exposure. It is not as coarse-crystalline as the Westchester county marbles.

NEW LEBANON, COLUMBIA COUNTY.—The marble quarries in this town were opened about fifty years ago. But they have been abandoned for many years.

GOUVERNEUR, ST. LAWRENCE CO.—At Governeur there are two companies at work quarrying marble—the St. Lawrence Marble Company and the Whitney Marble Company. Their works and quarries are located south-west of the village, about one mile distant. The St. Lawrence Marble Company's quarry is on the east side of the Rome, Watertown and Ogdensburg railroad line. This quarry was opened in 1878. The quarry is 100 x 90 feet and 70 feet deep, and at the side there is an additional area of 90 x 50 feet, from which the earth has been removed, leaving the marble ready for quarrying. The beds have a dip of 22°, and west of north. At the top the stone is light gray, the bottom is dark blue (resembling, when dressed, some of the gray granites). Both varieties are coarse-crystalline. At the junction of the two there are some impurities, due to a foreign admixture of mica and brown tourmaline and, rarely, pyrite, but this impure stone is thrown out as waste. The stone is very solid but splits most readily in the lines of the bedding. It is readily dressed, and is said to cut more easily than the Sutherland Falls marble, but it is not as soft as that of Rutland, Vermont. The crystalline rock, where uncovered, shows deep glacial furrows and smooth and polished surfaces. The covering of earth varies from a few inches to twelve feet in thickness. The stone is cut out by channelling machines, and the quarry proper may be said to be a rectangular pit, whose sides are nearly vertical. Very little water is met with in the quarry. Steam power is used for raising the water.

No powder is used and the stone is all cut out by machinery. The equipment consists of one steam derrick, a steam pump, four Sullivan diamond channelling machines, and one Ingersoll gadding machine. The mill for working up the stone is new and complete in its plan and equipment. A track from the quarry runs along the south side of the mill, and the large blocks as quarried are carried on cars directly to the works. There are sixteen gangs of saws with automatic feed, one rubbing bed and one turning lathe, and hoisting derrick for loading cut stone on the cars at the mill. The water for the works is obtained from a bored well 450 feet deep. The great use of this marble is for monuments. A large amount is sold for rock-ashlar, mostly to the western markets. The price for rock-ashlar at the quarry averages 25 cents per foot. The waste inferior stone is sold for common foundation and wall work in the village.

The Whitney Marble Company's quarry lies to the east of the St. Lawrence quarry and on the other side of the railroad track. The new quarry of this company measures 65 x 50 feet and 28 feet in depth. The earth on top of the stone is scarcely more than the thickness of the soil. The beds of marble dip 20° north, but a few yards away the dip is 25° north 30° east, showing considerable variation from point to point. The upper stone in this quarry is light in color and the bottom blue. Of the latter there is a thickness of 12 feet. A little mica and some tourmaline are noticed in the stone in the south-east corner of the quarry. In general the stone resembles that of the St. Lawrence Company's quarry, and is rather coarse-crystalline. In the quarry work one derrick, one Sullivan diamond channelling machine and one gadding machine are used. The quarry water is used for the boilers to run the machines. There is a small opening a few yards north of the present quarry, where some stone has been obtained. The old quarry on this property is about 150 yards north-east of the present opening, and is near the mill. This old opening has the dimension of 80 feet x 30 feet and is 50 feet in depth. It is no longer worked. The percentage of mica in the stone at the bottom makes it unfit for cutting or polishing, and hence the place is abandoned. One derrick still stands at the old quarry. The mill of this company has four gangs of saws, one rubbing table, one turning lathe and one loading derrick. A switch connects the mill with the main line of the railroad track, one-eighth of a mile distant. The greater part of the product goes for monumental work, but a part is put on the market for building purposes.

The Gouverneur marble was employed at least fifty years ago for grave-stones, and in the Riverside cemetery, at Gouverneur, these old grave-stones, bearing dates from 1818 onward, can now be seen. As compared with the more recently introduced Vermont, white marble head-stones it is more durable; and there is not so luxuriant a growth of moss and lichen as on the Vermont stone, but in the case of the older Gouverneur stone some signs of decay and disintegration, particularly on the tops, are noticeable, and small pieces can be chipped off with the knife blade. The durability of the stone for building purposes has been tested in some of the older structures in Gouverneur. Of course, it must be remembered that in them inferior and surface stone was used.

Gouverneur marble may be seen in a number of business blocks in the village of Gouverneur; in the Presbyterian church at Canton; in the Flower Memorial church at Watertown; in the county clerk's office, Albion; in three church buildings at Carthage; in the Merrick block, Syracuse; and in the Belden houses, Bryant avenue, Chicago.

CANTON.—A gray-white marble quarry is opened in this town, four miles easterly from Canton village. The stone is said to resemble that of the Gouverneur quarries. The place has not been worked lately.

Verd-Antique Marble.

THURMAN.—A verd-antique marble is found in the town of Thurman in Warren county. The locality is eight miles north-west of Thurman station and five miles from Glendale, on the Adirondack railroad. The place was worked by a Saratoga company (the Verd-Antique Marble Co.) for three years, when it was abandoned. Some stone was cut and dressed at the quarry and put on the market, but it was seamy, and the quarry was not deep enough to test thoroughly the formation. The stone is yellowish-green (as represented by Museum block) and not the rich, deep shade characteristic of the precious serpentine.

BOLTON.—Serpentine occurs in this town also, but it is not quarried.

PORT HENRY.—A beautiful, variegated, verd-antique marble has been opened near Port Henry, Essex county, but has not been developed. It occurs associated with the white, crystalline limestone. Fine specimen blocks are in the State Museum collection.

II.—SUB-CRYSTALLINE AND FRAGMENTAL ROCKS.

GROUP OF QUARTZYTE AND SANDSTONE.

Potsdam Sandstone.

FORT ANN, WASHINGTON COUNTY.—Jenkins White's quarry. The Potsdam sandstone is quarried at the side of the canal in a low bluff about two miles north of Fort Ann, and in the town of Fort Ann, Washington county. The working has opened the rock for over 100 yards in length, and the quarry face is at least 20 feet high. The beds have a gentle eastward dip and are traversed by vertical joints. The stone is grayish-white in color, hard and so close-grained as to resemble a quartzyte. The stone is used for building at Whitehall, and is shipped by canal.

WHITEHALL, WASHINGTON COUNTY.—There is a fine section of the Potsdam sandstone to be seen in the cliff east of this town. The edges of the strata form an almost vertical rise of 100 feet. The stone is quarried out for common masonry, as foundations, retaining walls, etc., and is a cheap and valuable building material for such purpose. It is hard and strong. Its use is limited to the town.

PORT HENRY, ESSEX COUNTY.—The Potsdam sandstone crops out at the side of the railroad, north of the railroad station, and in the hillside west of the town. These outcropping ledges have furnished stone for common walls and ordinary building purposes. The principal quarrying operations are on the hill, west of the town, and a quarter of a mile west of the Delaware and Hudson railroad line, and within half a mile of dock on the lake. This quarry is owned and worked by L. W. Bond. The opening is about 100 yards long, on the upper side of the wagon road which ascends the hill in a southern direction. Only about 8 feet of beds have been worked. The dip of the strata is 15° easterly, and the beds are from one inch to 15 inches thick. The rock is divided vertically by joints which are irregular in their course, but have smooth faces generally. Near the surface the stone is weathered to a brownish color. There is no covering of earth on the stone. The quarrying operations consist in wedging off the beds without the use of blasting material. The stone are broken readily into convenient sizes, and the blocks are carted to the town, which is the principal market for this quarry. It is used for retaining walls, foundation walls, and for sidewalks. It sells at 50 cents per rod at the quarry, and at 75 cents delivered on cars

or boat in the town. A few men are employed for a part of the year, and the product of this quarry is comparatively small.

KEESEVILLE.—The Potsdam sandstone which crops out at Keeseville and at Au Sable Chasm, in both Essex and Clinton counties, affords a large amount of good building material for local construction. It has been extensively used in these villages both in the public structures and in numerous private houses and stores, etc.

On the Port Kent road, at the eastern end of the village of Keeseville, the Prescott quarry is worked at intervals, according to the demand for building material and for flagging stone. The quarrying is simply the removal of the surface, outcropping strata; and in this way a large area has been worked over. The beds are thin, varying from two inches to one foot. They dip from 8° to 10° in an east-south-east direction. The stone has a grayish-white color, with some yellowish and darker gray bands. Across the road from this quarry the same formation is opened and worked quite down to the bank of the river. The beds are thin and dip eastward. The material obtained here is mostly for flagging purposes.

On the right bank of the river, at the end of the village, and in Essex county, Richard Hoag quarries sandstone. The strata dip easterly about 10°. The main joints run vertically south. The beds are from three to 18 inches thick. The stone is grayish-white in color, fine-grained and hard, and the face of the quarry is nearly 20 feet in height. This quarry is worked at intervals, according to the demand.

MALONE, FRANKLIN COUNTY.—Quarries have been long worked in and near Malone, in the valley of the Salmon river, for the local market. Sydney A. Paddock, Antone Morris and Peter Bajin have quarries here. The stone is gray-drab with some of a reddish yellow color. It is hard. The beds are usually thin and even. Natural face blocks are used whenever they can be had. And in the town all the foundation walls, the retaining walls, bridges, sidewalk stone and several buildings are of this sandstone. Its durability is attested by its good state of preservation in these structures.

POTSDAM, ST. LAWRENCE COUNTY.—The formation in which the quarries of sandstone above described are found derives its name from this locality. The Raquette river in its northward passage has cut through and exposed the strata of sandstone for several miles. Four quarries have been opened along the stream at an average distance of three miles south-south-east of Potsdam.

The most southern quarry is owned by Mrs. Charles Cox. It was formerly worked by the Potsdam Sandstone Company. It is on the left bank of the river and close to the water. The covering of drift earth and sandstone strata is 20 to 30 feet thick at the west, and the same thickness was observed in the strata uncovered to the eastward. On the north the covering is only five feet thick. A striking feature of this quarry is the change in the direction of the strike, due apparently to a fault. At the west side the beds dip 35° to 38° S. 25° W., and the same dip and direction appear on the east side, but in the middle section of the quarry, having a breadth of 20 yards, approximately, the dip is 38° S. 65° W. The opening is not more than 90 yards long from north to south, and 50 yards wide at the north. The deeper part of the quarry has now 30 to 40 feet of water in it. The stone on the north side is thin-bedded, and these thin beds are worked for flagging and for crosswalk stone. The joints or "cut-offs" are vertical, or nearly so, and run generally in an easterly and westerly direction. A second system of joints runs nearly vertically, north and south, and these joints are generally close enough together to give convenient size to the blocks. Some of the strata show oblique lamination, but in general the layers are parallel with the bedding planes. The lamination is prominent in the stone because of diverse coloring, being red, gray and black, and hence some of the dark-lined stone is here locally termed "black stone." Very little work is done at this quarry and that is in getting flagging and crosswalk stone, and the stone is sold to dealers. The beds are wedged off by bars and split by sledging and hammer-dressed to sizes wanted.

The quarry of Thomas S. Clarkson is about a fourth of a mile down stream on the left bank. The covering here is 50 feet thick, and consists of a glacial drift; and the upper surface of the stone is glaciated. The beds dip at an angle of 10° to the south-west. The The main joints run vertically in a south-westerly course. The face of this quarry opens to the south, and is about 100 yards long from east to west. Blocks of a very large size can here be obtained, as large as can be conveniently removed from the quarry. The drainage is natural, and no machinery is employed. The great thickness of the covering on the quarry stone makes the working of this quarry expensive, and it is no longer worked vigorously as in former years. The stone is fine-grained, compact and hard, and mostly of a salmon color. The dark-lined or "black stone" is harder to dress than the lighter colored varieties.

THE POTSDAM RED SANDSTONE COMPANY QUARRY.—This quarry is on the east side or the right bank of the Raquette river, about one-eighth of a mile above Clarkson's, and at a point where there is a bend in the river. The earth covering on the stone at this quarry is of an average thickness of 10 feet—in places amounting to as much as 15 feet. The length of the quarry face is not more than 100 yards from north-north-west to south-south-east, and the total thickness of the quarry beds averages 25 feet. The dip is 22° N., 80° to 85° W. One system of joints, or "cut-offs," runs north and south, and dips easterly; another system courses north-west and dips 65° in a south-westerly direction. The first of these "cut-offs" is close, or what is known as a "tight joint." They assist greatly in the work of quarrying the stone. The beds in this quarry vary in thickness from four inches up to a maximum of six feet. Slabs four inches and upwards can be split off from these beds. The lamination is not as plain or as marked as it is in Clarkson's quarry, and hence the stone has a more homogeneous texture and appearance. It is lighter in shade, and nearly salmon color, varying to a faint pink shade, which is pleasing to the eye. It splits readily in planes parallel to the beds. It is hard; hence difficult to dress, and its hardness is shown by the frequent necessity of sharpening the drills used in cutting up the stone. Very little powder and dynamite are used in breaking up the larger blocks. There are two derricks and four steam drills. On an average, forty men are employed in this quarry, and the working season continues until freezing weather. In winter the work of cutting and dressing the stone is carried on in the sheds, which are on the river bank at the quarry.

About a quarter of a mile north of this quarry, and on the same side of the river, stone was formerly obtained for local uses, but this locality is no longer worked.

All of the stone from these Potsdam quarries has to be hauled by teams to Potsdam for shipment. On account of its hardness and the increased expense of dressing, and its liability to split on the lines of lamination, parallel to the beds, it is not so well adapted for fine cutting, but it is easily wrought and handsome for rock-ashlar. And for dwellings, its use is increasing rapidly.

The Potsdam sandstone can be seen in the Florence Flats, Syracuse; All Saints' Cathedral, Albany; the Reid buildings, Seventh avenue and Sterling street, Brooklyn; and in the Columbia College buildings, New York city. In the town of Potsdam the Normal

School buildings are of this stone; also the Presbyterian church, the Universalist church, the Protestant Episcopal church, the Town Hall, and a number of store and dwelling-houses. Its durability has been tested in some of the old houses in the place, which are fifty to sixty years of age, and in which the stone is still sharp-edged, without a sign of scale or disintegration. The stone in the sidewalks in the town is from these quarries; and it is admirable for flagging material, inasmuch as it does not wear smooth and become slippery, and dries quickly after being wet with rain.

In order to facilitate the working of these quarries and increase their output, a railway from Potsdam to the quarries is projected.

HAMMOND, ST. LAWRENCE COUNTY.—In the town of Hammond there are three sandstone quarries, which are now in operation: W. H. Stanley's, a half a mile south of Rossie station; D. E. Parmeter's, one and a half miles north of the same station; and H. A. Foster's, two and a half miles north of it. The Finnegan quarry, a half a mile north of Parmeter's quarry, is idle.

H. A. Foster's quarry is about 300 yards east of the Rome, Watertown & Ogdensburg railroad and on the west of the Black creek, and at the top of a bold ledge, 30 to 40 feet high, which bounds the Black creek ravine on the west side. The quarry consists of this cleared ledge for a length of 200 yards from north to south, running back in extreme breadth about 50 feet. The greatest depth is only about 10 feet. A wide joint system runs parallel to the ledge front, *i. e.*, north and south. These joints or seams are quite open, from one to two feet in places, and five to ten feet apart. Another system of joints, vertical, runs in a north-westerly course, but the north and south system dips steeply to the east, in places. The dip of the sandstone strata is less than 5°, and in an easterly direction. The upper surface rock of the quarry is glaciated and grooved. The beds are generally thin. The stone is grayish-white and hard, but dresses readily and breaks *true*, so that it is adapted for making paving blocks. The main product of this quarry is for street work, either as heavy flagging-stone or paving blocks. There are no derricks and no machinery in use. Very little powder is needed to break up waste rock. A side track runs from the quarry to the main railroad line. The drainage is natural, and the waste is shovelled directly over the ledge into the Black creek ravine. Hence the locality is worked to

advantage, and the length of the outcrop shows a great stock of stone. The lower beds, *i. e.*, below the present quarry bottom to the foot of the ledge have not as yet been opened or tested. They are exposed in the face of the bluff. This quarry was opened in June, 1887.

The Finnegan quarry is on the west side of the Rome, Watertown & Ogdensburgh railroad, and about half way between Rossie station and Foster's quarry. The quarry is in the eastern face of the ledge for a distance of 200 or 300 yards, and on the side of the track. The beds are thin and horizontal. One main system of joints runs east and west. The second runs N. 20° W. Much of the stone at this place is striped in color, red and white. It was worked for paving blocks and flagging-stone. It has been idle for five years.

The quarry of D. E. Parmeter also occupies the eastern face of the ledge or bluff, and is on the west side of the railroad. Its workings extend along the line of the railroad nearly 1,000 feet, from north-east to south-west. The floor, or bottom of the quarry, is about on a level with a platform car on the side track, making, as it were, a convenient natural dock. The stone at the bottom is hard and solid, and suitable for building, but it is not used. The quarry beds furnish a sufficient quantity for paving blocks, which is the great business of this quarry also. Their total (or the maximum) thickness, as seen at the north-west end of the opening, is 25 feet. The dip does not exceed 5°, and is east-south-east. The most plain and regular joint system runs north-east and south-west, and vertically, but not uniformly so. Some of them dip steeply. An open system of joints, less regular and less frequent, runs north and south. These joints facilitate the quarrying. The maximum thickness of the soil on top of this quarry is less than three feet. The beds of stone are from a few inches to three feet thick, but the thickest can be split up into thin flagging-stone. Generally they do not run in uniform thickness, but wedge out, as it were, forming basins, showing much irregularity in the original deposition. At the south end of the quarry the stone is striped, red and white, resembling some of the stone at the Finnegan quarry. It is broken up for paving blocks. The best stone of the quarry is white, or grayish-white in color, and fine grained. It is hard, but is readily split into convenient sizes for paving blocks. No blasting is done here. The beds are lifted by means of bars, and are split crosswise by drilling line holes and sledging, or by plug and feather wedges. The drainage is natural. There is

one derrick at the north-west end of the quarry. The output is mainly paving blocks. Some curb-stone, gutter-stone and crosswalk stone are taken out. As there is little local demand for building stone the lower, heavy beds, which are adapted for building, are not worked. This stone is not considered quite as hard as that of the Potsdam quarries, but this difference may be due to the fact that in this quarry the upper beds only are worked, whereas at Potsdam the quarry beds are deep, covered by earth and thin-bedded rock. The Parmeter quarry was opened twelve years ago.

The quarry of W. H. Stanley is in the town of Hammond, and is situated on the east side of the Rome, Watertown & Ogdensburg railroad convenient to transportation. The dip of the strata at this quarry is a few degrees eastward. The product is mainly paving blocks and some flagging-stone. The location is very similar to that of the Parmeter quarry.

The Hammond quarries are at present worked almost exclusively for street paving material. The product is shipped to western cities. The lower and heavier beds, which are adapted to building stone, are left unopened on account of the want of a local market and the more profitable business in making blocks. A large force of men is employed, and the aggregate output is large. The geological formation is Potsdam sandstone.

CLAYTON, JEFFERSON COUNTY.— The Potsdom sandstone crops out in the village of Clayton, and is generally covered by a thin layer of earth. The stone, which is got out in excavating for foundations, is used in building. It is gray, fine-grained and quite hard and suited for common wall work only. There is a small quarry near the dock on the water's edge, but it is worked in a small way.

Sandstone of the Hudson River Group.

HIGHLAND, ULSTER COUNTY.—The quarry of A. S. Clearwater is on the bank of the Hudson river, two miles north of Highland station, on the west side of the West Shóre railroad track. The strata dip at an angle of 20° east-north-east, and the rock is very regularly bedded. The beds are thick, up to five to seven feet, and one is 11 feet thick. Well-marked, vertical joints divide the rock, running in a north-westerly and south-easterly direction, and a second system runs north-east and south-west. The stone is

blue, fine-grained sandstone. Occasionally small, slaty pebbles are seen in it. By taking advantage of the joints a single blast forces off great blocks, whose thickness is that of the bed, and which are then split up by the use of plug and feather wedges. At the top of the quarry there is a bed or tier 4 feet 9 inches thick, which is thus worked up into blocks one foot on a side and 4 feet 9 inches long. Near the bottom of the quarry there is an eleven-foot bed. The stone is hauled by teams under the West Shore track to the dock on the river or is loaded directly on the cars at the side of the track. It is shipped to New York city mainly, and for heavy work. The smaller stone are sold for dock filling.

RHINEBECK, DUTCHESS COUNTY.—The N. Y. C. & H. R. R. R. Company works a quarry a half mile south of Rhinebeck station, and in a bluff on the east side of the track. The bluff here has a height of 100 feet, approximately. The strata dip to the north-east at an angle of 35°, but there is a variation at the top, going southward, as well as to the north. Owing to this formation the best stone occupies the middle part of the face of the quarry as now opened. There are no well-marked joints traversing this rock. Some of the stone is black and shaly, and falls to pieces on exposure to the weather. The best, and that which is quarried for construction, occurs in beds from one to two and a half feet thick. It is of a grayish shade in color, and is a rather coarse-grained sandstone. On account of its hardness it is not readily dressed, and its principal use is by the company for the construction of bridges, culverts and roadway walls.

NEW BALTIMORE, GREENE COUNTY.—Four quarries are opened in the sandstone of the Hudson River slate formation at and near New Baltimore, on the Hudson, in Greene county. Beginning at the north, Smith & McCabe's quarry is in the river bluff at the north end of the village. The beds thus exposed for a length of about 100 yards along the river dip steeply eastward. The stone is dark-gray to slate-colored and fine-grained. This quarry is worked at irregular intervals of time, according as there is a demand for stone.

South of the village there are openings for a mile down the river, and all are somewhat alike in their exposure, kind of stone and in shipping dock accommodations. The stone may be described as a blue, slate-colored, fine-grained sandstone. The beds of sandstone are associated with interbedded, thin layers of shale, and are wea-

thered to a drab-colored rock on their outcropping edges. The waste, consisting of some top-dirt and the shaly strata, is thrown into the river on the front, making room for dockage; and the stone is shipped by boat to its destination. The principal use of this stone has been for dock-filling and for dykes on the upper part of the Hudson river. About twenty men are employed in the aggregate by these quarries. Formerly the business was much larger and many men were employed.

The first quarry south of the village is owned by A. V. S. Vanderpool. It is less than a half a mile south of it. The quarry face runs from north-north-east to south-south-west for 100 yards, and is worked back a distance of 25 yards. The present quarry work is in the line of strike, south 30° west. The beds are vertical, excepting at the top, where they are bent over to the east, an inclination apparently the result of glacial forces. A prominent joint system has its plane dipping 30° to the north-east. The quarry face has an extreme height of 100 feet at the south-west, and is 50 feet high at the north. The earth covering on the top is thin. The workable beds are dark drab-colored to blue, and are from six inches to eight feet thick. They are interstratified with a fissile, black slate, which varies in its layers from two inches to six inches in thickness. There are two thick beds of stone—one of eight feet, near the middle and the other three feet thick, at the back, or west. At the south-east corner of the quarry the beds have been disturbed by folding; and there the stone is harder than elsewhere in the quarry. The joint planes of division help in the quarrying, and the stone is rather readily broken into rectangular blocks of convenient size and shape. The quarry has a dock at river front, at which large vessels can load. It has been opened about 30 years.

Another opening on the same property is nearly 100 yards south of this one. It is not now in operation as a quarry. The beds in it dip 70° to the west-north-west.

Andrew Matthews' quarry is nearly one mile south of the village. Its dimensions are, approximately, 80 yards in length and 30 yards in width, and having a height of 50 feet at the back. The strata stand vertically. A remarkable fault (here termed a *slip-foot*) is seen at the west side. Its plane dips 30° eastward, and on the top section, looking southward, the strata are folded closely, with upper part of the synclinal cut off; on the bottom and below the faulting plane the beds dip eastward at an angle of 30°, conformably to the plane. The

sandstone is fine-grained, of a bluish shade of color, and is in thick beds. Some beds of slaty rock occur with the standstone. The stone splits readily along planes in bedding and where there are thin laminæ of calcite and quartz, known as "hair seams" and "salt seams." There is a dock on front at which boats are loaded. The quarry furnished stone for foundation of the Reformed church at Castleton. Formerly a great market was at Albany. It has been opened 23 years. To the south a few rods there is an abandoned quarry also owned by Matthews.

James Bronk's quarry, worked by Fuller & Sons, adjoins the abandoned Matthews' quarry. A large area at the north is no longer worked. The present quarrying operations are confined to a length of 200 feet. The strata here dip toward the north-east and at an average inclination of 30°. The beds are thick. One near the top measures 10 feet. And there is relatively less of the shaly or slaty rock here than in the other quarries of this group. There is a dock on the river where boats are loaded.

The New Baltimore quarries have no machinery for hoisting or drilling. Common black powder is in use for blasting. The stone are carted to the boats. And the whole product is sold for common walls or for dykes. The prices range from 30 cents per cubic yard on the dock to 75 cents and one dollar per yard, delivered on dykes in river, or for better grade of building stone.

TROY, RENSSELAER COUNTY.—Sandstone of the Hudson river group is quarried in this city for foundation work exclusively, and for the home market. Sampson's quarry on Pawling avenue, near the Memorial church, leased by William McLaughlin, is worked by a small force of men a part of the year.

Havernan's quarry on Fourth street, south of the Poestenkill, is run by the owner, and from eight to twenty men are employed. The sandstone is interbedded with slaty rock in these quarries, and there is some waste in the working. The stone is not adapted to fine dressing or cut work.

AT AQUEDUCT, SCHENECTADY COUNTY, there are three quarries. The largest one of these quarries is that of Levi Smith, on the south bank of the Erie canal and a half a mile west of Aqueduct station. It has a length from north-east to south-west of 800 feet. The order of succession of the strata from the surface is:

1. Earth..........................	1 to 2 feet.
2. Thin, slaty layers alternating with beds of standstone..........................	10 feet.
3. Blue sandstone..........................	10 feet.
4. Slate (as pierced in well hole)............	3 feet.

In the upper ten feet there are three beds of sandstone, 2½ feet, 2 feet and 1 foot thick, respectively. The dip of the strata is less than 2° and is to the south-east. There are two well-marked systems of joints; one runs south 32° west, and dips 88° to north-west; the other runs south 59° east and dips 85° to 88° to south-west. These joints divide the rock into rectangular and step-like masses, and are at convenient distances for working. The stone splits readily and true, and is easily wrought into blocks for common wall work. Very little powder is used, as the masses are broken off by bars and split by sledging. There are no "sap faces" on the stone, and very little calcite or pyrite. The stone is fine-grained. It is in the horizon of the Hudson River slate and sandstone. And the bottom rock is black slate, containing scattering sandstone pebbles and mud cracks. No fossil organisms are found in any of the quarry beds. The drainage is natural, nearly to the floor of the quarry; a Worthington pump raises the water from the bottom to the level of the outflow to the canal. A rock breaker at the side of the railroad track uses the spalls and waste for road and street material. The stone is carted in wagons to the railroad side track (within a quarter of a mile of the quarry), or is loaded on canal boats at the side of the quarry. Albany, Cohoes, and Troy are the chief markets. The stone is known in the market as "Schenectady blue stone." The working season continues from March to December. This quarry was opened in 1862.

Levi Benedict's quarry is north of Aqueduct station an eighth of a mile, and has the canal on its west side. The opening is about 60 yards long and 30 feet deep. The strata dip southward at an angle of less than 5°. One main joint has a course of south 42° west. Another of south 55° west; and their planes dip 85° to north-west. There is a third system whose direction is in general south-east, and whose plane dips 85° to south-west, but it is not so well defined as the others. The vertical succession of the strata is:

1. Slate, brownish colored..........................	10 feet.
2. Slate and blue sandstone..........................	9 feet.
3. Blue sandstone..........................	2 feet.

The slaty rock is waste. The quarry is worked at irregular times.

About 20 rods north of the above mentioned quarry there is another opening in the side of the bluff, and higher above the canal. And in it the dip of the beds is as much as 7°, and southward.

Across the river, and on the Saratoga county side, sandstone has been quarried at Rexford Flats by C. W. Rexford.

SCHENECTADY.—The quarry of Shears & Dunsbach is one mile easterly from the railroad station, but within the city limits. It is 100 yards south of the railroad and the Erie canal. Its extent from north-east to south-west is at least 200 yards, and 100 yards from north to south. The drainage is natural and northward to the canal. The stone is covered by a true glacial drift, which has in it large imbedded masses of stone and boulders of all sizes. This boulder earth is so hard and firm in places as to require blasting to break it down. The glacial forces appear to have removed all the rotten or disintegrated stone and slaty beds, and to have covered and protected the solid rock mass. Hence the top stone is good for quarrying. Unlike the Aquduct quarries, there is no slaty rock at the top or interbedded with the sandstone. The drift earth is from four to ten feet thick. The quarry beds are from one to three feet thick, and the total thickness is from 10 to 15 feet. The dip is less than 5°, and in a south-west direction. The main system of joints runs south 50° west. A second system has its course south 15° west. A third system runs at right angles to the first one, but is not well marked. They are vertical or dip steeply to the north-west. The stone is of a bluish shade of color and is fine-grained. As the joints are at convenient intervals for working and the stone is readily broken in planes at right angles to beds and joints, blocks of rectangular shape and of good size are obtained without the use of much powder. And the natural faces save dressing for much wall work. No machinery is in use. The stone is carted to railroad or canal, 100 yards away, or is taken to the building sites in the city directly, by teams. It is used in Troy, Cohoes, Waterford and Albany, as well as largely at home, and is known in the market as "Schenectady blue stone." A large amount goes into foundations. It can be seen as rock-ashlar in the East Avenue Presbyterian church in the city and in the Memorial Hall of Union College. The quarry was opened about 15 years ago, but little was done in it until nine years ago. The extent of stone and its solid character make the quarry valuable, and a source for supply to the adjacent country.

The shaly nature of much of the Hudson River group of rocks in the Mohawk valley, west of Schenectady, and the accessibility of good limestone for building purposes, has prevented the opening of quarries in it. Further west, and near Rome, there are small qarries which are referred to this horizon, but they are unimportant. The sandstone quarries in the towns of Camden, Oneida county, and of Orwell in Oswego county, belong in it. The stone is generally gray in color, fine-grained and hard and in moderately thick beds. None of these quarries do much more than a small local business; and they are not in operation all the working season of the year.

Medina Sandstone.

OSWEGO.—Quarries have been opened in this city from the Fort Ontario grounds eastward to the N. Y., O. & Western R. R. Co.'s shops on the lake shore. They are small, and are worked by a few men, at irregular times, for stone to be used in the construction of foundation and retaining walls. The covering of earth is shallow—on average three feet thick—then a shaly rock in thin beds, and under it the quarry beds from five to eight feet thick. The stone is light gray in color and rather coarse-grained, but it is strong and hard and suitable for inside walls, foundations, etc. A large quantity has been put into buildings in the city. In the United States grounds there is a large quarry. It has been idle for many years. The formation belongs to the Medina epoch.

OSWEGO FALLS, OSWEGO COUNTY.—The Medina sandstone formation, as exposed along the Oswego river, is worked for building stone at several points near the village of Oswego Falls. One of the quarries is on the lands of a mill company and near the falls and on the left bank of the stream. It has been idle for years.

About a quarter of a mile north-west, on the left bank of the stream, Hughes Brothers, of Syracuse, have a quarry—James Faulkner and Michael Nealis are the lessees. It was opened 16 years ago. The succession of strata is as follows: First, sandy loam, 3 feet 2 inches; red, sandy earth and shaly rock, 11 feet; red sandstone beds, 19 feet; clay and rotten rock, 3 inches; red sandstone, 14 feet. A well sunk for the removal of water showed 10 feet of sandstone below the quarry bottom. The old quarry pit, north-west of the present face, or working, is now filled with water to a depth of 16 feet, and no beds below the water level are worked. The beds dip very slightly to the west. So far as observed, one vertical joint only

appears. Its course is north-west. Generally the beds of sandstone are separated by thin layers of shaly rock. The top stone is somewhat inferior, on account of its shaly pebbles, which on exposure crumble and fall out. The more solid beds, near the main water level of the stream, make good stone for dressing and cut work. The inferior stone is sold for common walls and foundations. The cut and dressed material is used chiefly for house trimmings or rock-face ashlar. The market for the greater part of the product is Syracuse. There is one derrick; and the stone are loaded directly on boats at the side of the canal. The stone in this quarry is dark red in color, rather soft, and dresses easily. At the bottom it is harder and more homogeneous in texture. Some of the upper strata have a *reedy* structure.

A large amount of stone has been taken from the strata on the river banks at Oswego Falls, and used in Fulton, and in Oswego and Syracuse. Owing to a lack of care in selection much inferior stone has gone into the market, and it has greatly injured the reputation of the Oswego Falls stone. The First Presbyterian church in Syracuse, corner of South Salina and Fayette streets, is an example of this stone, badly selected, and to a large extent with the blocks set on edge. And withal this stone has a rich, deep and pleasing tint; and its weathered blocks give the edifice an appearance of age.

GRANBY BROWNSTONE COMPANY'S QUARRY.—This quarry is in the town of Granby, two miles from Fulton and at the side of the Delaware, Lackawana & Western railroad. The first opening was made in the spring of 1886, and the present quarry consists of a square pit, 85 feet on the side and 60 feet deep. The work here has been done by the use of a channelling machine. The quarry is in a little depression, and the earth covering on the rock was scarcely a foot thick. For three feet down the rock is shaly and somewhat broken up. And down at least 16 feet the stone is traversed by irregularly running seams; and there are shaly pebbles in the sandstone; and some parts of the stone have a grayish-green color, as if the stone were not so thoroughly oxidized in them as in the main mass. These shaly portions disintegrate on exposure, fall out and disfigure the stone. The bottom rock is quite free from them and from seams also. It is fine-grained, of a purple red shade of color, and admits of fine tool dressing, and is adapted to highly ornamental work. In the quarrying work there are in use: one Ingersoll channelling machine; one Ingersoll drill; two steam derricks and a steam pump. The

boiler-house stands close to the quarry. A side track about 200 yards in length connects the quarry with the main line of railroad. Very little trouble is experienced from water, and a brook near by supplies the necessary water for the boiler. By means of a channelling machine the sides of the quarry are cut down, and the blocks are split apart by plug and feather wedges. The blocks cut apart in this way are lifted by wedging them off the bed. Blocks as large as can be conveniently handled, can be obtained. The stone is suited to fine dressed, ornamental work or for heavy masonry, but care is needed to select stone free from seams and from shale pebbles. The Granby stone is being used in the building of the Second National Bank of Oswego, now in course of erection. And it has been put into the Protestant Episcopal church edifice and ten store buildings in Cortland.

CAMDEN, ONEIDA COUNTY.—A sandstone, presumably in the Medina formation, is quarried in this town, for local use. It is light gray in color, and coarse-grained. The greater part of the stone is used for flagging. Some of it is shipped to Oswego.

The Medina sandstone formation has yielded some building stone in the town of Sterling in Cayuga county, and in Wolcott in Wayne county, but the quarries there opened have been worked for local use only and to a small extent. A little stone has been taken out in Penfield, Monroe county, but the Genesee river marks the eastward limit of the more extensive quarry district in this formation.

Medina sandstone, in its more restricted sense, is quarried near the line of the Erie canal, from Brockport, in Monroe county, west to Lockport, in Niagara county. At Rochester the Genesee gorge exposes to view the sandstone, and formerly some stone was quarried in the city.* Of late years it has been neglected, and the stone from the quarries further west has been used in its place.

BROCKPORT.—Two quarries are opened at this place. They are owned by Geo. Coon and Hugh Quinn.

HOLLEY, ORLEANS COUNTY.—There are three quarries in operation near Holley station on the N. Y. Central railroad. The quarry of Gorman & Slack is nearest to the station, and on the south side of the Erie canal. It is opened in a level country and adjoins the canal.

* See Hall's Report on Fourth District, pp. 432-3.

The *stripping* of drift earth and some imbedded angular masses of sandstone is thin. The stone of this quarry has a light red color, and is fine-grained. It is worked into paving blocks * and into building material. A side track at the quarry affords convenient facilities for loading directly from the quarry.

The quarry of Timothy O'Brien is three-quarters of a mile east of the Holley station, and on the south side of the railroad track, and also of the Erie canal. It was opened in 1881. About three acres has here been worked over. The *stripping* consists of drift earth, largely made up of fragments and masses of broken sandstone. The beds of stone here, as in the Gorman & Slack quarry, are horizontal. A marked feature is a system of joints, which runs east and west, and dips steeply north, and 15 to 20 feet apart. A second system, not so commonly observed, runs south, and in a more irregular course and dip. The total thickness of the rock quarried ranges from 7 to 15 feet, and the bottom rock is a coarse-granular, dark-brown sandstone, which is very hard and breaks hackly. Underneath this bottom rock is a red sandstone bed known as "red horse." The quarry water has to be raised four feet to the level of the outflowing ditches which carry it off north to the canal. The product is mainly paving blocks, with some stone for building purposes. The stone is sold in the rough for crosswalks, curbing and general building work. Much of it goes to Rochester; some to Buffalo. A large force of men is here employed for about seven months in the year, or until the beginning of freezing weather.

One mile south of Holley an old quarry, known as the "cider mill quarry," has been reopened the past season by Hiram Joslyn, of Holley.

HULBERTON, ORLEANS COUNTY.—The Hulberton group of quarries are located on the north side of, and close to the Erie canal. Beginning at the east, the first opening is that of Sturaker & Sullivan. This quarry was first opened in 1884. The *stripping* on the stone consists of earth and broken stone, a few feet thick. The workable beds together are 10 feet thick, and at the bottom is a dark, brownish-red, coarse-granular sandstone. The quarry runs about 250 feet in length, parallel to the canal. One system of joints runs east and west, vertically. The others run in an irregular course. Some of the beds are obliquely laminated, and at the bottom, on the east side,

* The paving blocks made in these quarries are, in part, sold with the product of the Albion quarries, and are known as Medina paving blocks.

there is a sloping floor, dipping 18 to 20° south-west, against which the red sandstone of the quarry beds abut. The output of this quarry is largely paving blocks, which are carted to the canal and shipped by boat. The stone of the beds which are worked, is red, and fine-grained.

The next quarry, going west, is that of Thos. Lardner. This is also close to the canal, and measures about 200 feet on a side. At the top the earth, boulders and imbedded masses of sandstone form the *stripping*, which is six feet thick. The quarry beds aggregate in thickness 12 feet. A well some 14 feet below the bottom, is all in sandstone. The beds are thin, and the stone in some of them is coarse-grained. The general direction of the joints is east and west. Much of the stone is shipped to Rochester for rubble work and for cellar walls. It is sold there at as low a rate as Rochester limestone of the city quarries. A large part of the stone is worked into paving blocks, curbing and crosswalks. This quarry was opened in 1884.

Barnard O'Reilly's quarry is about 60 rods north-west of Lardner's and on the same side of the canal, and 20 rods, approximately, from it. Its dimensions are about 300 feet each way, and 25 to 30 feet in depth. The *stripping* consists of earth and broken stone to a depth of 10 feet. Some good stone is obtained from these loose masses in the top earth. The quarry beds are from 4 to 10 inches thick, and have a total thickness of 15 to 18 feet. The joints are very irregular, and some of them curved. They are also remarkable for being open and filled with dirt. These open or dirt-filled *seams* are of great service in the extraction of the stone. The stone is mostly red in color, fine-grained and breaks readily and *true*. One steam pump raises the quarry water. Two derricks are used in hoisting the stone. It is carted to the canal and shipped by boat. The product is mainly paving blocks and street material (curbing and crosswalks). The principal markets are Cleveland, Toledo and Indianapolis. This quarry was opened in 1882.

Alfred Squire's quarry is within 300 yards of the O'Reilly quarry north-west and on the same side of the canal. It is about 350 feet long and 200 feet wide. The *stripping* of earth and imbedded stone does not exceed 8 feet. Then come a few thin beds, which are used for street work, and for common blocks. Under them a thick-bedded sandstone is quarried. There are no regular joints or *seams*, but irregularly curved joints occur at distances convenient for getting

out the stone. The bottom floor of the quarry is a dark-brown, coarse-grained sandstone. Blocks of very large size can be obtained. In fact, the limit to the size is that of handling and transportation. All of the thick-bedded stone and the larger part of the product of this quarry is worked into building material, and is shipped in the rough. A steam pump is in use for raising the water; there are two derricks for hoisting the stone. It is carted to the canal and shipped by boat. This quarry was opened in 1865. The stone of the thick beds is fine-grained, of even texture and of a light-red color. Stone of the Squire's quarry can be seen in the Delaware Avenue M. E. church, in Buffalo; in the Sibley Hall, Cornell University, Ithaca, and many other structures. Rochester and Buffalo are the principal markets.

Lafayette Cornwell's quarry is the next one to the north-west. It was opened in 1887. The quarry beds are from 2 to 12 inches thick; and in all, there is a thickness of 7 feet of such quarry stone, underlying 5 feet of *stripping*. The stone is deep-red in color. It is suitable for building or street work. A small number of men are employed.

Going on, north-west there are the quarries of Constantine Van York, Charles Gwin, Barnard O'Reilly (leased to M. Scanlon) and Chadwick Brothers.

The Hulberton quarries are all embraced within a narrow belt on the north side of the Erie canal, two and a half miles in length, from north-west to south-east. They are all excavated below the level of the canal, and hence the pumping of water is necessitated in all of them. Their stone is shipped over the canal; and in all about 120 men are employed in these quarries. The working season continues from spring until freezing weather, in the early winter. Much of the Hulberton block is sold by the Albion Stone Company, and goes under the name of Medina block.

ALBION, ORLEANS COUNTY.—The largest quarries in the Medina sandstone formation are at Albion. They are on the east of the town, and opened in a comparatively flat, farming country, between the Erie canal on the north and the New York Central railroad on the south. They are below the railroad grade and not much above the canal level. The most westerly opening is in the town, and is known as Sandford's quarry. A large area has been quarried over. It is now idle.

The GOODRICH & CLARK STONE COMPANY'S QUARRY is the next one, going eastward, and is about half way between the canal and the railroad. It was opened three years ago. The excavation is about 350 feet long, from east to west, and 300 feet wide. The *stripping* consists of sandy earth, from 3 to 10 feet thick, and imbedded in it there is some broken stone. This quarry has been worked to a depth of about 18 feet. The beds dip to the south at a very low angle. The joints run east and west generally or south 85° west, and are from 12 30 feet apart. A second system runs north and south, and dips steeply eastward. At the south side the beds are thin. On the north they are thicker, up to four feet. The stone is red in color, fine-grained, with some greenish-grey laminæ on the bedding planes, or what may be termed sap edges. They are usually less than a quarter of an inch thick. Some of the beds show a striped, laminated structure. Some are marked by cross bedding, while others are entirely homogeneous in texture. The stone can be split readily in planes parallel to the bedding. The upper sides are generally smooth, true and faintly lined as if wind had drifted sand over the original surfaces. And these surfaces are good for platforms and flagging-stone. The water of the quarry passes into a sewer at the bottom of the quarry, and goes north under the canal. Some of the stone is sold for common rubble work. A part of the inferior or poorer grade is split into paving blocks; the best is used for building stone or paving blocks. The stone is carted to the canal and shipped by boat to destination.

ALBION STONE COMPANY'S QUARRY.—This property embraces the old Sickles quarry, and what is known as the Sullivan quarry. It was first opened thirty years ago. The present company has connected these quarries by its working; and the present excavation is now nearly 2,000 feet long, from east to west. At the west end the quarry has advanced quite to the railroad line. The total area worked over is approximately estimated at eight acres. The *stripping* at the west end consists of earth and thin, shaly rock, having a thickness of 10 feet. Eastward the shale disappears, and the earth alone averages 10 feet thick. It is of a red, sandy nature, and is readily removed. On the west this quarry approaches within a few rods the east line of the Goodrich & Clark Company's quarry, but it extends much further to the south. The beds vary in thickness, thinning out wedge-like, as others come in to replace them. So also the stone varies in character from point to point, even in the same

bed. The thickest bed is 6 feet. The general direction of the main system of joints or seams is east and west, and vertical. The others are irregular. In some cases they are filled with earth, and these dirt seams help greatly in the working of the quarry. The total thickness of the quarry beds at the south amounts to 30 feet. It is less on both the east and west sides. Some powder is used, but so far as possible the beds are lifted off by wedges, and split apart by plug and feather. The stone is carted to the cars at the side of the quarry, on the south, or to the canal on the north. The water at the bottom of the quarry is pumped to the level of the drain, which flows north into the canal. There are two derricks in the quarry for hoisting the stone. The beds here also have a smooth upper surface, and what are known as sand lines. Oblique lamination is seen in some of the beds, and where thus laminated, the stone is cut up into paving blocks. The best stone is sold for building purposes and platform flagging, but the greater part of the product goes for paving blocks; and principally to Cleveland, Columbus, Toledo, and other places in the west. For paving material two grades are made; one is known as the block pavement, and the other the common, natural face stone. A large number of men are employed at this quarry throughout the working season, and the annual output amounts to hundreds of car loads. The stone of this quarry is rather brighter red than that of the other Albion quarries, approaching the Hulberton stone in shade. It is fine-grained and even in texture. The Presbyterian church in Albion is a beautiful example in construction, of this company's stone.

GILBERT BRADY'S QUARRY is less than half a mile east of the last described, and one and a half miles from the Albion railroad station. It is similarly situated in reference to the canal and railroad. The face of the quarry has its greatest length from east to west, and the whole distance from the east end to the west end is 150 rods. The *stripping*, of red sand, varies from 10 to 15 feet thick, and the surface of the stone underneath this sand bed is glaciated and hard and solid, as if the upper and shaly strata had been removed therefrom by the glacier. The beds have a general dip of a few degrees to the south-east. A remarkable feature of this quarry is the uniformity in the direction, and in the spaces between the seams or joints. The direction of these seams is nearly east and west and vertical, and they are from 12 to 30 feet apart; and in nearly all cases filled with

earth. The north and south seams or joints are not as common and not so regular. The stone is brown in color, with thin, gray-green layers at the bed parting. On the faces of the seams it is often a rusty red. The color generally, is not so bright as that of the stone of the Albion Stone Company's quarry. The quality varies greatly in narrow belts from east to west. The best stone is found at the extreme front, on the south. On the west side of the quarry the beds are of a darker-brown shade and coarse-grained; and this stone breaks unevenly. It is split up into blocks. Unlike the other Albion quarries, the greater part of the output is building stone, and is the best material of the quarry. Only that which is not good for building purposes is split into blocks. The total thickness of the quarry beds is 14 feet. The upper surfaces of the beds here also are smooth, and marked by lines of wind-drifted sand, as are seen to-day on the strand at the seaside. The working of the quarry is largely determined and helped by the regular joints; and it moves southward, taking a section between these vertical seams at a time. As the northern end is free, the beds are readily wedged off and raised up. Very little powder is used. Steam drills are employed to put down holes, in line from joint to joint, for splitting apart. There are fourteen derricks, all of which are worked by hand, not counting the derricks at the canal dock, which are used for loading. A road follows the face of the quarry around from east to west, and the stone are loaded directly on wagons, and carted to canal or railroad. As the excavation moves south the area worked over is filled again with waste stone and earth, and is thus returned to farm land. This quarry has been worked more than thirty years by Mr. Brady. It is a model for neatness, convenient arrangement and economic management, as well as one of the best quarries for superior building stone. The stone are cut and dressed at the yard of Gilbert Brady & Company, in Rochester. Examples of this stone in construction are: the Guernsey building, Broadway; Marquand house, Madison avenue and Sixty-eight street, in New York city; Gen. McDougal's house in Auburn; and the steps of the new staircase, west side of capitol at Albany. In Rochester and Buffalo there are numerous structures in which it has been used.

The total output of the Albion sandstone quarries is estimated by Mr. Gilbert Brady to amount to 45,000 tons. About 400 men are employed during the season of quarrying, and the value of the stone for all uses is estimated at $250,000.

MEDINA, ORLEANS COUNTY.—Near the town of Medina there are nine quarries, which are worked more or less all of the time during the quarrying season. They are north and north-east of the town and all are within a mile and a half of the railroad station. They have been in operation for many years, and the aggregate area worked over is large. The total number of men employed in these quarries, in the height of the season, amounts to 450, and the working period lasts from May to November. The stone at Medina differs from that of the Albion quarries in the gray-white color of much of it, and in the abundance of fossil shells and fucoid impressions in some of the layers. The stone generally is harder. The spotted, red and white, or variegated stone, also is a feature of the Medina quarries. Oblique lamination of the beds is more common than at Albion or Hulberton. Pyrite-coated seams or joint faces also are to be noted, as a mark of the formation which is seen in the older quarries especially. Formerly the gray or white stone was in fashion, and nearly all of the gray variety was sold for building. The present demand for building is for the red and variegated varieties, and all of the gray stone and much of the red stone are split into blocks for paving. And a comparatively small fraction of the total output is put into market for construction.

KEARNEY & BARRETT.—The quarry of Kearney & Barrett is on the north side of the Erie canal, in the north-west part of the village of Medina, and a half a mile from the New York Central railroad station. It was opened in 1840. A large area has here been worked over, close to the canal property, having a length, from east to west of 1,500 feet, and an estimated area of seven acres. The *stripping* consists of a red, sandy earth, in places quick-sand, with some imbedded masses of sandstone. The sandstone in this top material yields a sufficient amount of workable stone to pay for its removal. The thickness of the *stripping* varies from two to three feet at the west end and ten feet on the south side. The greatest thickness of the quarry beds, as here worked, amounts to 30 feet. In the middle of the quarry the shale, which is known as "red horse," rises up in a north and south belt, running across the quarry, and very little good stone is obtained from that part of the quarry. The dip is very gentle southward. A main system of joints or seams runs east and west. The second system runs north-west and south-east, but not nearly so regular as the first. A third system courses north, but dips about 60° east. There is a noticeable variation in the bedding

from point to point, and the beds are seen to thin out while others form thick lenticular masses between these more narrow, wedge-shaped beds. Cross-bedding and oblique lamination are also common. The beds vary in thickness from a few inches to three and four feet. On the eastern side of the quarry there is at the bottom a heavy bed of what is known as variegated rock, and under it a thick bed of white sandstone. In this variegated rock the matrix is red, and in it are these white, spheroidal masses. In working, the color guides in the separation and selection of the stone, according as the demand calls for several kinds. The red stone is now most in favor. The variegated is also highly esteemed. Steam pumps are used for unwatering the quarry, but no steam drills are used. The stone is carted by team to the canal and railroad. The product is building stone for house trimmings, rock-ashlar, paving blocks; crosswalk and curb stone are also obtained. The chief markets are Columbus, Detroit, Kansas City, Cleveland, Rochester, Buffalo and Erie. The quarry is worked about seven months in the year, and at times as many as 100 men are employed.

JAMES HOWELL.—This quarry is east of the last described, and between the two roads leading north and west from the village. Its face, fronting east-north-east, has a length of nearly 1,000 feet, in somewhat of a zigzag course. The *stripping* is light, containing some broken stone with the top earth. Near the top there are shaly beds interstratified with the sandstone. These disappear down, and then the sandstone beds are heavier. The whole thickness of the quarry beds here worked, amounts to 18 feet. The product is almost wholly for street work. This quarry, like that of Kearney & Barrett's, is below the canal level, and the water accumulating in it has to be raised by power.

JOHN A. HOLLOWAY.— This quarry is on the right bank of the creek, and on the west side of the canal. The working face at present is towards the west, and has a length of 500 feet from north to south. A large area has here been worked over, and huge dumps lie disposed about the quarry. The *stripping* 3½ feet thick is shaly beds. The quarry beds have a total thickness of from 10 to 12 feet. The drainage is natural into the creek. The seams are somewhat irregular, and some of the beds are much disturbed and broken by them. In some cases the joint faces are coated with pyrite. The stone is mostly grayish-white, hard, and some of it shows oblique

lamination. The quarry is worked on contract, for paving stone, the men furnishiug the tools and receiving so much per cord for stone quarried. The stone is carted to the canal, a few rods east of the quarry.

PATRICK HORAN.—North of Holloway's quarry is that of Patrick Horan, on the west side of the main road, and west of the canal also. The length of the working face, which fronts on the west, is about 800 feet, and a breadth of about 500 feet has been worked over. At the south end the drift earth covering the stone is 6 feet thick, and the quarry beds have a total thickness of 18 feet. At the west end there is 12 feet of earth, and then 12 feet of stone to the level of the water, and natural drainage. The older working was 10 to 12 feet deeper, making in all 22 feet to 24 feet of beds quarried. The beds are quite irregular, and vary from a few inches to 2 feet in thickness. There is some spotted, red and white (or variegated stone as here known) at the top, but the prevailing shade is gray, especially at the bottom. Some of the beds are obliquely laminated, and these work up badly. No machinery is employed, and this quarry is worked in a small way.

JOHN A. HOLLOWAY'S QUARRIES.—These quarries lie east of the road and east of the last described. There are two separate openings and about 40 yards apart. At the northern-most quarry the *stripping* is from 5 to 6 feet thick, below which there are from 10 to 12 feet of beds, which are workable, mostly a grayish-white stone. At the south the quarry covering is from 5 to 8 feet thick, and the quarry beds aggregate 12 to 18 feet. Nearly all of the stone is a gray-white in color, known in the market, however, as white stone. The product of these quarries goes into street work and building stone.

PATRICK HORAN.—Horan's main quarry is a quarter of a mile east of Holloway's, and one mile north-east of the Medina railroad station, and about sixty rods from the canal. Two and half acres have here been worked over, and the quarry has a length of 600 feet from north to south. The *stripping* is from 12 to 15 feet thick, and contains some imbedded masses of sandstone, which are worked up into building stone. The quarry beds have a total thickness of 10 to 12 feet, and range from a few inches to 2½ feet thick. The common feature here observed is the irregular or uneven strata, thinning out or wedging out between others and basin-shaped beds. At the bot-

tom there is a greenish-gray and mottled rock, which is so seamy and has so much iron oxide on it that it is worthless. The stone of the quarry beds is nearly all of a red or deep brown color, and fine-grained, but variations in texture and in shade of color from bed to bed and from point to point in the same bed, is observed here as in all of these Medina quarries. One main system of joints runs vertically east and west, but somewhat irregular in its course. A steam pump is used for raising the water. The stone is carted to the canal. The product of these quarries consists of building stone, which is sold in the rough generally, and is used for house trimmings and for rock-ashlar. The stone for street work is flagging and platforms, some of which are as much as 20 feet in length and having smooth natural faces. Stone for curbing, crosswalks and natural face blocks are also produced. A large force of men is employed, and the output of the quarry is large.

McCORMICK.—A. J. McCormick's quarry is north-east of Horan's, and separate from it by a property line only. The south front, or face of the quarry, has an eastern and western course, and is on a line with Horan's north limit. On the east of this main quarry there is a second and smaller opening, also belonging to McCormick. It was opened in 1871. The eastern opening is worked at times, for paving stone principally. The main quarry has an estimated area of four to five acres. The *stripping* here is red, sandy earth, with scattering masses of sandstone imbedded in it, and is five feet thick. Under it is an inferior, shaly, thin-bedded, reddish sandstone, three feet thick, suitable for common wall stone only. Then come the quarry beds which are from 2 inches to 6 feet thick, together amounting to 15 or 18 feet. The thick beds can be riven into platforms, flagging stone, etc., if so wanted, or are sold for building. The dip of the beds, as at all of these Medina quarries, is south and at a very small angle, and hence as the quarry work moves south, successive beds appear at the top. The joints are regular; one system east and west, being vertical and one system north-east and south-west, but more irregular. The faces of these joints or seams are in part coated with pyrite. The stone is red, with a little of it variegated. No derricks are used. The water is raised by steam power. There is a quarry dock on the canal a quarter of a mile away. The product is largely for street work, such as curbstone, crosswalk-stone, flag-stone and paving blocks. Some stone for rock-faced ashlar, for buildings and for house trimmings, is sold, mostly in the rough. It is

shipped by rail and canal. The curbstone and crosswalk-stone are dressed at the quarry.

NOBLE & LYLE QUARRY.—This quarry is situated a quarter of a mile north of the canal and one and a half miles north-east of Medina, on lands of Hiram Reynolds. It has been in operation about twelve years. It is about 100 yards in diameter, being nearly circular in shape. The earth covering is from five to six feet thick; the quarry beds from one to three feet thick, and have a total thickness of 16 feet. They dip south at a small angle. The bedding of this quarry is very regular and even, and there is an entire absence of oblique lamination and basin-shaped beds. The rock at the bottom is seamy, and worthless on account of its shaly nature, and is known as "red horse." The stone is generally of a brown or reddish-brown color, more like the Hulberton than the Medina stone. It is rather softer than the stone of the other Medina quarries, and is easily dressed. Some of the beds on the east side are of a grayish-white color, and harder. The product is almost wholly put into building material. A very little is sold for curbing, flagging, crosswalks, and for paving block.

LOCKPORT.—On the north of Lockport the Medina sandstone formation has been opened at a number of points on an 80-acre tract owned by Chas. Whitmore. These quarries are on both sides of the road leading to Olcott, and on the right bank of Eighteen-mile creek.* Work has been done on the hill north-east of this Olcott road in a small way, in many separate excavations, which are from three to five feet deep. The product, a gray sandstone, is split up into paving blocks. South-west of the road, and in the face of the bluff, and below the smelting works, the main quarries are located, which are now worked. The *stripping* is heavy, 18 to 20 feet thick, including red, shaly beds, with hard sandstone, most of which is thrown out as waste. The quarry beds dip gently south. The vertical joints run generally east and west, dividing the rock into convenient blocks for quarrying. Both red and mottled varieties occur in this locality. The inferior stone from the top courses or strata sells in Lockport, delivered, at $3.00 per cord. The lower beds furnish stone for curbing and street work. The total thickness of the white

* The Medina gray and mottled sandstones from these Lockport quarries were much used formerly, and many of the older buildings in the lower part of the town are constructed of them. And they afford the best evidence of the durability of the Lockport sandstone. The quarries here are said to have been opened as early as 1824.

and mottled stone is here, on an average, 10 feet thick. A railway track one mile in length connects these quarries with the main line of the N. Y. Central railroad in the town.

Sandstone of the Clinton Group.

This formation furnishes a building stone in Herkimer and Oneida counties, south of the Mohawk valley and east-south-east of Oneida lake. There are quarries in the towns of Frankfort, New Hartford, Kirkland and Verona. Utica uses the largest part of the stone from the quarries at Clinton and those on Frankfort Hill. The Frankfort Hill stone is of dark-gray to red-brown shades of color, medium fine-grained and hard to dress. It is largely used for foundation walls. It is seen in the walls of the Grace P. E. church on Genesee street, and in the Lutheran church on Columbia street. At Clinton sandstone is quarried by Charles Dawes, John McCabe and Michael McDermott. In Verona a small quarry has been opened near the line of the N. Y. C. R. R. The stone is in thin beds and is gray in color. The Rome railroad depot is built of this stone.

At Higginsville an old quarry has been reopened this season by a Utica company, and preparations have been made to do a large business. The locality is on the line of the old Oneida canal and five miles from the Central railroad. There is a light covering of sand on the stone. The upper beds are thin; they increase as they get down; and at the bottom there is a bed four and a half feet thick. The stone is dark-gray to olive-green in color; some in the top beds is reddish-brown. It is hard and is not split easily. About 12 feet of the stone is above the natural drainage. The place has been opened forty years, and most of the stone has been used in Rome. Latterly some of it has been tried in Utica, and it has given satisfaction. It looks especially well when used with limestone trimmings or with Massachusetts red sandstone. A fine example of the stone is the Gilbert mansion on Genesee street in that city, which was erected seven years ago.

Hamilton and Portage Groups.

Hudson River Blue-stone.

The term "Hudson river blue-stone" is used to designate the blue, fine-grained, compact and even-bedded sandstone, which is so largely employed for flagging in New York, and more or less in all of our Atlantic coast cities and towns. It is extensively used for house

trimmings also, and hence the common name of "Hudson river flagstone," or "North river flagstone," is not quite as comprehensive as that of "blue-stone." The belt of country in which it is quarried is nearly 100 miles long in New York, stretching from the south-western towns of Albany county, across Greene and Ulster and the western part of Orange and eastern part of Sullivan counties to the Delaware river. In Albany and Greene counties it is narrow, as also in Saugerties in Ulster county, making the foot hills, as it were, on the east and east-south-east of the Catskill mountains, and bounded on the east by the older limestone formations. It widens in the towns of Kingston, Woodstock, Hurley, Olive and Marbletown, and in them the quarries are distributed over the 500-foot plateau which borders the mountains on the south-east. To the north-west, and in the valley of the Esopus creek, many localities near the line of the Ulster & Delaware railroad have been opened and worked. They are a part of the blue-stone district geographically, although the geological formations are not the equivalent of the main belt at the south-east. There are scattering localities in the towns of Rochester and Wawarsing and thence south-west, in Sullivan county which furnish blue-stone for local markets, and for exportation where they are situated near enough to lines of shipping.

The belt, as above described, has in it outcrops of shales and sandstones, belonging to the several geological formations, from the Hamilton period to and including the Catskill, in short, rocks of the Upper Devonian age. There are quarries along the Hudson river at New Baltimore, and thence southward, at Coxsackie and Catskill and near Rondout, but they are not in the typical blue-stone, but in the sandstone of the Hudson River slate formation. The quarries of Palenville and vicinity, of West Saugerties, High Woods, Boiceville, Phœnicia, Woodland Hollow, Shandaken and Pine Hill are above the horizon of the Hamilton formation and probably all in the Catskill group of rocks. The Oneonta sandstone, which is the equivalent of the Portage group, may form a part of the belt near the foot of the mountains, but it is impossible to define its limits and to designate the quarries in it. The quarries at Roxbury and Margaretville and their vicinity, are in the Catskill formation. And the openings along the Monticello railroad, in Sullivan county, are probably in the same horizon. The main blue-stone belt, where it has been so extensively opened, as in the towns of Saugerties, Kingston and Hurley, is of the Hamilton period. And it is significant that it

should have been so productive a region. And if a part be of the Oneonta or Portage, the remarkable fact comes out that they are in the same geological horizon as the great quarries of Ohio stone (Berea and Amherst).

Beginning at the north-east, there are small quarries at Reidsville and Dormansville, seven miles west of the Hudson river, and in Albany county. They have furnished a great deal of stone for flagging in the city of Albany. The stone of these quarries is gray in color and rather coarser-grained than the typical blue-stone of the Hudson river quarries.

In Greene county there are several small quarries near Leeds, which are worked mainly for the Catskill market. In the vicinity of Cairo stone is quarried at several places, and shipped by rail. On the line of the Stony Clove & Catskill Mountain railroad and along the Kaaterskill railroad quarries have been opened, from the mountain houses to Phœnicia. The quarries at Kiskatom and Palenville are not so actively worked as in former years. Their stone goes to Malden, seven to nine miles distant.

Ulster county is the largest producer of blue-stone, and the aggregate output of its many quarries exceeds the combined product of all the other counties in the belt or blue-stone territory. Its quarry districts may be grouped as follows:

1. Quarryville, in the northern part of the town of Saugerties.
2. West Saugerties, in the western part of the town of Saugerties.
3. High Woods, in the town of Saugerties.
4. Dutch Settlement, in the town of Kingston.
5. Hallihan Hill, in the town of Kingston.
6. Jockey Hill, in the town of Kingston.
7. Dutch Hill, in the town of Kingston.
8. Stony Hollow, in the town of Kingston.
9. Bristol Hill, in the town of Hurley.
10. Morgan Hill, in the town of Hurley.
11. Steenykill, in the town of Hurley.
12. West Hurley, in the town of Hurley.
13. Marbletown, in the town of Marbletown.
14. Woodstock, in the town of Woodstock.
15. Broadhead's Bridge, in the town of Olive.
16. Shokan and Boiceville, in the town of Olive.
17. Phœnicia and Woodland Hollow in Shandaken.
18. Fox Hollow and Shandaken in Shandaken.

19. Pine Hill in Shandaken.
20. Rochester and Wawarsing quarries in valley of Rondout creek and its tributaries, north-west of Wawarsing and Ellenville.

Of course it must be understood that there is much variation in these many quarries, in the thickness and nature of the overlying earth and cap-rock, or what is generally termed the "*stripping*," in the number and thickness of the workable beds, in their "*lay*" or dip, in the direction and spacing of the joints or "headers" and "side seams," in the kind of stone and in the natural advantages of location for economic working. The many openings and their history seem to show that the whole territory is underlain with beds of bluestone, but in large areas the stone is of inferior quality, or the thickness of quarry beds is not great enough to warrant their working with profit. And the abandoned quarries are the localities generally, where the *stripping* has become too great for removal, or where the stone has thinned out or has been, as it were, replaced by worthless rock. In some cases the localities are left on account of too long haulage to transportation lines. The tendency of later years has been toward railway or canal to save cartage, and the back districts have decreased in their production. Thus there has been an increase in the number of localities opened and in the output of the territory adjacent to the Ulster and Delaware railroad. In practice it is found that where the distance exceeds ten miles, quarrying is scarcely profitable, unless in exceptional cases. And so with the *stripping*, where it is over 20 feet, the quarry beds must be thick and the stone of good quality to pay for its removal. A rule is that the total thickness of quarry beds must not be less than one-third of the *stripping*.

The stone of the Saugerties quarries is carted to Malden and to Saugerties. The quarry districts in Kingston ship their stone from Wilbur, on the Rondout creek, or load on cars at Stony Hollow.

Some of the Hurley quarries also send their stone by team to Wilbur. For the other districts in the towns of Olive, Woodstock and Shandaken, the Ulster and Delaware railroad is the natural outlet line. The quarries near Ellenville and Wawarsing are nearer to the Delaware and Hudson Canal, and the N. Y. O. & Western railroad, and the greater part of their stone is shipped to New York and other points.

In working, the general custom formerly was, to lease the land at

a certain royalty per square foot of stone taken out, about a half a cent per square foot, but now the rate ranges from five to ten per cent royalty. Few of the quarries are run by companies or on a large scale. Nearly all of them are worked by a single party or by the associated effort of two or three men of small capital, or more often by laborers themselves uniting their labor. Hence little or no machinery is to be seen at the greater number. Generally a loading derrick, worked by hand-power and a small hand-pump make up the equipment. At the larger quarries horse-power derricks, for lifting the stone from their beds, and loading derricks at the railroad dock, are in use. The quarries in the Esopus creek valley and in Wood stock are nearly all in steep hillsides and the drainage is natural. And in nearly all of the quarries in the lower country the situation is such that little or no water has to be raised.

In quarrying the rock is thrown down or broken up by the use of common, blasting powder, until the quarry beds are reached. The latter are split apart into convenient sizes by the use of plug and feather wedges, driven in shallow holes, set in lines across the block. The natural division planes, or joints are taken advantage of in cutting up the blocks. These joints are generally vertical, or nearly so, and run in two systems, the one parallel to the strike of the beds, or the ledge also, and the other system at right angles to the first and in the line or direction of the dip of the beds. The former make the successive "headers" or face of the quarry; the latter are known as the end joints. The average distance between the latter is from 10 to 20 or 30 feet. Where they are regular and well defined, as they are in nearly all of the larger quarries, the blocks or slabs of stone are readily cut into rectangular-shaped sizes for platforms, sidewalk, crosswalk and curbing stone. The beds of stone range from an inch to three feet in thickness, and in some instances six feet, as at Quarryville, the top beds generally being thinner than those deeper in the quarry. In working into the hills the bedding planes or divisions sometimes disappear and two or more thin layers coalesce into one thick bed. In most cases these thick strata can be split along planes parallel to the bedding. And the cap layer is lifted off by means of wedging on the edges. The size of blocks is determined by the natural joints, and stone 60 feet by 20 feet have been lifted from the bed. The facilities for handling and shipping limit the size. It is customary to use the thinner stone for town or village sidewalks. The thicker stone are cut into curbing, or crosswalk and sidewalk, or

what is known, as *flag-stone*.. The heavier beds make the large platforms or heavy flagging for cities. But some of it is cut into dimension stone for water-tables, sills, lintels, posts and window caps, or for house trimmings in general.

The stone obtained in these several districts varies in color, hardness and texture and consequently in value, from quarry to quarry, and even in the same quarry opening. In nearly all of the localities the beds vary a little from top downwards; rarely is there much variation horizontally, or in the same bed. Hence any given bed may be said to have a certain character, that is, produces a given grade of stone. The color is predominently dark-gray or bluish-gray, and hence (more by contrast with the red sandstones) a "blue-stone." Reddish-brown and some greenish-gray stones occur in the quarries higher in the mountain sides, as in the valley of the Esopus creek above Shokan and in the Palenville quarries. There is a decided preference for the typical "blue-stone" over the reddish or brownish-colored grades. In texture the range is from the fine, shaly or argillaceous to the highly siliceous and even conglomeratic rock. Interstratified with the workable beds in all quarries there are shaly layers which crumble and fall to earth in time, when exposed to the atmosphere. The cap-rock is often thus, in part, shaly, and thin layers of shale between the heavy sandstone *lifts* are common. The best blue-stone is rather fine-grained and not very plainly laminated, and its mass is nearly all silica or quartz, which is cemented together by a siliceous paste and contains very little argillaceous matter. Hence the stone is hard and durable and has great strength or capacity of resistance to crushing or compression. Coarse-grained sandstones and even fine conglomerates occur and are quarried in some localities. It should be stated here that little of the sandstone is loosely cemented together and friable; and it is rarely open and porous.

The "blue-stone" territory south-west of Ulster county is confined to a narrow belt crossing the towns of Mamakating, Thompson, Forestburgh and Lumberland in Sullivan county, and Deerpark in Orange county. And there are quarries near Westbrookville, near Wurtsborough, along the Monticello railroad and on the Delaware river at Pond-Eddy and Barryville. The last mentioned place is famous for the large size of the flag-stone sent to New York city for the Vanderbilt property.*

*They came from Barryville; as follows:.....	1—	26 feet x 15 feet 4 inch x 7 inch.
	1—	10 feet x 15 feet 1 "
Afterwards quarried sizes as follows: }	....1—	15 feet x 17 feet "
20 ft.x30x10 ft.—"Hickock quarry," }	....1—	18.6 ft. x 15 feet "

North-west of the belt of country above described, flag-stone is obtained along the lines of the N. Y., O. & Western railroad, and of the Ulster & Delaware railroad at Westfield Flats, Trout Brook, East Branch, Margaretville, Roxbury and Grand Gorge, and in lesser amounts at other localities. As it comes to the market with that of the quarries in Ulster county, it is included in the "blue-stone" production. All of these quarries are in the Catskill group of rocks and the stone is more generally a reddish or a brown-tinted sandstone. As a rule it is more *open-grained* and not so dense and strong as the Ulster county stone. A well-marked division is the watershed or divide between the Hudson and the east branch of the Delaware river. The "blue-stone" belt cannot be said to extend beyond the head waters of the Esopus, the Rondout and the Neversink, or, in other words, is confined to their drainage valleys.

As has been indicated, the product of the blue-stone territory reaches the market by the Hudson river (boats), the Ulster and Delaware, the New York, Ontario and Western, and the New York, Lake Erie and Western railroads and the Delaware and Hudson canal. The principal shipping points are Malden, Saugerties and Kingston (including Wilbur and Rondout). A great deal of stone is cut for house trimmings in mills at Malden, at Broadhead's Bridge, West Hurley, Wilbur, Kingston and Rondout, but, probably, the larger number of feet are sent into market, simply quarry dressed, for flagging and curbing. It is the flagging *par excellence.* All the residents of New York city and the adjacent towns in New York and New Jersey, recognize its superiority for sidewalks, crosswalks and for curbing. It so compact as not to absorb moisture to any extent, and hence soon dries after rain or ice; it has the hardness to resist abrasion and wears well; it is even-bedded, and thus presents a good and smooth natural surface; and it has a grain which prevents it becoming smooth and slippery as some of our granites, our slates and our limestones, when so used, in walks. It is strong, and is not apt to get broken. But owing to the many thin beds and the use of too thin stones, sidewalks often become unsightly and bad because of breaks, a fault common to all flag-stone when laid in such thin beds or blocks.

For use in houses and business buildings Hudson river blue-stone is having an increasing market. It is admirably adapted for lintels, window caps, sills, door steps, water tables, etc., with brick, both because of its strength and its durability. None of our sandstones

from other districts, and not even our best granites, are as strong to resist transverse pressure or strain. Tests (comparative) show that it is fully three times as strong, in this way of resistance, as granite, marble, Ohio sandstone and Connecticut and New Jersey brownstones. To resist compression it is not much superior to these sandstones, and not equal to the best granites. And its strength against transverse strains fits it for lintels, sills, caps, and water tables especially. The use for house-trimming material is increasing as compared with what is sold for flagging and curbing or for street work. And the mills in the district are increasing their product from year to year. The output of blue-stone in 1887 is estimated at 6,500,000 feet.*

MONROE, ORANGE COUNTY.—Quarries for flag-stone are opened on the southern end of Skunnemunk mountain, near the Seven Springs Mountain House, and three miles north-west of Monroe. The strata are thin and lie nearly horizontal. The stone is gray, coarse-grained and rather hard and brittle and there are too many thin beds. The quarries are no longer worked, excepting to meet the occasional wants of the neighboring country.

HUNTER'S LAND, SOHOHARIE COUNTY.—Blue-stone for flagging is quarried at several places in the vicinity of Hunter's Land, south-east and east of Middleburgh. The quarries are in side hills, and the strata lie nearly horizontal, and they are in the Hamilton formation. Their output is carted to Middleburgh, whence it is shipped by rail to Albany, Troy and cities in the eastern States. This group of quarries may be considered as a part of the blue-stone district, although not in the Hudson river belt. The formation is the same, and the stone are similar in appearance and texture, and they are only separated by the narrow divide between the watersheds of the Mohawk and the Hudson rivers.

Small quarries for flagging for local uses have been opened at EMINENCE, a few miles south-west of Middleburgh.

OXFORD, CHENANGO COUNTY.—The quarry of F. G. Clarke & Sons is north-west of Oxford village, on the west side of the Chenango valley, and at an elevation of 150 feet above the railroad. The rock is covered by from 25 to 30 feet of drift earth, in which are large, imbedded boulders. The opening is on the west side of and

* See appendix for full statistics.

above the stream, so that the drainage of the quarry is natural. It was first opened ten years ago. The drift earth is broken down by blasting, and is carried away in cars on a tramway to the dump near the bottom of the ravine. The face of the quarry is about 500 feet in length, from north to south, but the working is confined to 300 feet at the south end. The *stripping* is done in the winter season, after the quarry work is over. As the excavation moves westward, and into the hillside, new strata appear at the top, and thus the total thickness of the quarry beds is increased so much. The strata are horizontal. A remarkably regular series of joints are in the upper courses or *tiers* of stone, in an east-north-east direction, and they are from 15 inches to 23 feet apart. They do not go down into the thick-bedded stone at the bottom, which is known as *liver-rock*. Some of them are close and are known as "silver" joints or seams, the surfaces being coated with calcite; others are filled with mud (mud joints or seams) in thickness from two to four inches. Cross seams or headers are rarely seen. The top stone, for a depth of 10 feet downward, is thin-bedded and shaly in part, and is practically waste and is thrown out on the dump. Some of it would answer for common walls or rubble work, but owing to the lack of a market, it is not used. Then there are beds which are from four inches upwards, thick, and having a total thickness of 10 feet, which are used for platforms. Stone 22 feet long by 10 feet, or as wide as can be shipped, can be obtained. And the surfaces are very smooth; they make admirable platform stone. At the bottom there are two thick beds, each 4 feet thick, which are known as *liver-rock*. They are cut by channelling machine. The stone has a blue shade in color, and a homogeneous texture, and is capable of receiving fine dressing. At the bottom there is a bed of hard, blue stone, which has not been tested. This quarry might go deeper without sinking below the level of the water. A crushing test of the strength of this stone, made in 1884, showed a resistance of 12,152 to 13,472 pounds to the square inch. The equipment consists of one derrick for removing the stone from the drift earth, one derrick in the quarry and one on the dressing grounds (all of which are worked by horse power), one boiler-house, one Ingersoll channelling machine, and one steam drill. Works for sawing and dressing the stone, to be run by steam power, are now in course of erection, not far from the quarry, and in the village. The stone is carted to the D., L. & W. railroad, three-quarters of a mile away. The principal market is New York city, and the output the

last year was large. The price for the best stone averages about 90 cents per cubic feet. Among the examples of buildings of this stone may be noted: the Aldrich Court building on Broadway, New York city; and St. Lawrence hall, Yale University, New Haven, Conn. With increased facilities for quarrying and a dressing works the output promises to be larger than heretofore.

The stone is known as the "Oxford blue sandstone," although in color it has a greenish-gray tinge. It is geologically in the Oneonta formation. In the more shaly beds plant remains are often observed. This quarry was first opened ten years ago.

COVENTRY.—F. G. Clarke & Sons have another quarry, four miles south-east of Oxford and in the town of COVENTRY. It was opened in 1885; and is one mile from the railway station. The stone here quarried is nearly all cut into flagging; but a little is carted to Oxford and used in foundation walls. It is fine-grained and of a bluish shade of color.

Four miles west of Oxford stone is quarried by Berry Loomis and Walker Brothers. The product is mainly flagging, which is loaded on the cars at Coventry station. About a dozen men are employed in these quarries.

SMITHVILLE FLATS.—Formerly flagging of large size and in heavy beds was quarried at this place, on lands of Mrs. Harrison, but the distance to railroad, eight miles, and low prices, have prevented further working. And the quarry has been idle for two years.

GUILFORD.—Flag-stone is quarried by several parties at New Berlin Junction, on the N. Y., O. & W. R. R., in the town of Guilford. The average number of men employed is about six for the year. The stone is sold at Syracuse.

ONEONTA, OTSEGO COUNTY.—A small quarry supplies the flagging and some common, building stone which is wanted in the town. It is a thin-bedded, blue sandstone.

COOPERSTOWN, OTSEGO COUNTY.—A quarry in the sandstone of the Hamilton formation, and on the eastern side of Otsego lake, is worked at irregular intervals, to fill orders for localities within easy hauling distance. The stone is fine-grained, and is easily dressed. It is used for foundation work mainly.

GOODYEAR'S, CAYUGA COUNTY.—Two miles east of Cayuga lake and Atwater station J. G. Barger quarries flagging and building stone in the Hamilton formation. The covering on the quarry beds averages eight feet in thickness. Then there is flagstone in five *lifts*; then shale, about 2 feet thick; then two beds, each about 2 feet thick separated by shale; or in the aggregate, 6 feet of quarry beds and 12 feet of waste. The stone is carted to the railroad station on the lake shore. The greater part is cut into flagging; the stone unsuited to flagging is for building. Some of it has been cut and rubbed for house work, at Cayuga, at Parker's Glen, Pa., and also at works on the Hudson river. The principal markets are at Seneca Falls, Canandaigua, Utica, Rochester and New York. The quarry was opened first in 1864.

TRUMANSBURGH, TOMPKINS COUNTY.—Near Trumansburgh several quarries have been opened in sandstone, mainly for flagging. The most important one is that of the Flagstone & Building Stone Company, one mile east of the village, and three-quarters of a mile from the shore of Cayuga lake. The quarry is on the right bank of the Trumansburgh creek, and has a length of 500 feet, from east to west, and a breadth of 250 feet, approximately. Its average depth is 25 feet. There is no *stripping* of consequence, as only two inches of soil covers the rock. The beds at the top are somewhat shaly. Common building stone is obtained from them. The thinner beds at the bottom are used for cutting into dimension stone. The total thickness of the strata is 25 feet, which range from one foot thick down, of which only about seven feet; or less than 30 per cent, are used. The dip is very slightly north-west. One very regular system of joints is vertical, and at spaces six to eight feet apart, and runs 2° west of north. The quarry has a natural drainage. The stone is carted to a dock on the lake, and shipped by boat to the company's yard at Mott Haven, New York, or to Cayuga, where it is cut into lintels, sills and curbing, and then shipped to New York. It has a grayish shade of color, is fine-grained, and is readily cut into dimension stone for house trimmings and curbing. In the winter season the work of *stripping* is carried on. About 20 men are employed, and a large amount of flagging is taken out.

A few rods west of this opening, a brownish-colored sandstone crops out, and which is opened and quarried for building stone. It was used for the Protestant Episcopal church in the village. Some

of the blocks have natural faces. and are of a dirty yellow shade in color. Others show a reedy structure.

Near Halseyville and a half a mile east of the Trumansburgh and Ithaca road there are quarries on both sides of the Taughannock creek, worked by D. S. Biggs. On the south side of the stream the *stripping* of earth is 18 feet thick, and on the north side 10 feet thick. The beds are horizontal, with vertical joints at convenient distances apart for working. From the north quarry more flag-stone is obtained ; from that on the south side more building stone. None of the strata are more than 18 inches thick, and shale is interbedded with the stone, but all of them split readily into slabs and flag-stone of convenient sizes. On account of the shaly rock there is much waste in these quarries. The drainage is natural. Two small derricks comprise the equipment. The flag-stone are carted two miles to lake, but the railroad station is only a half mile away. This quarry was opened in 1884.

A short distance down stream, on the right side is Dumont's quarry for flag-stone, and near it is still another small quarry. All of these quarries sell stone to the works at Cayuga, whence it goes to Syracuse, Geneva, Rochester, etc., besides the local markets.

In Kingtown, a hamlet in the town of Covert, there are two small flag-stone quarries, which are worked as the demand calls for stone. Only a few men are employed in each.

ITHACA, TOMPKINS COUNTY.— Sandstone is quarried on the hill south of the town, at two places by G. C. McClune. The older quarry is one mile south of the corporation line and about 200 feet above the valley. The *stripping* is mostly shale and some rough stone, the best of which is used for common walls. The flag-stone layers are from 14 inches to 28 inches thick, and from 5 to 12 layers of the flagging, from 1 to 8 inches thick. are obtained. The strata dip at about 1 in 24, southward. The quarry was opened in 1838; and it has yielded a large amount of stone. The other quarry is 80 rods easterly from the first and within three-quarters of a mile of the town line. It was opened in 1875. The beds are more irregular and the stone is not so fine-grained as in the other. These quarries furnish flagging for Ithaca and vicinity.

Sandstone for the Cornell University buildings was quarried on the site of Cascadilla Hall, and at a quarry in front of the main building, but lower on the hillside. Another quarry was opened near the

McGraw-Fisk mansion and Fall Creek. The stone in Cascadilla Hall is the best from these local quarries.

The Ithaca stone is fine-grained and has a greenish-gray tinge. Natural face blocks are apt to show stains and look rusty or dirty yellow. When selected with care and dressed as rock-face ashlar it makes a substantial looking building. Nearly all of the foundation and basement-wall stone in the place are from these home quarries. When in rough-pointed or crandalled blocks in course work it looks well.

The geological horizon of these quarries is Portage.

WATKINS GLEN, SCHUYLER COUNTY.—A sandstone in the Portage group is here opened and worked by the Northern Central Railroad Company, for its construction on its lines both north and south. The stone is reported to be fine-grained and evenly-bedded.

PENN YAN, YATES COUNTY.—Sandstone for foundation walls is quarried near Head street, by Geo. R. Cornwell; and at Thayer Bros. quarry, on the east side of the lake, three miles from Penn Yan.

PORTAGE, LIVINGSTON COUNTY.—The quarry of Peter Pitkin is located two miles south of Portageville and three miles from Portage station on the N. Y., L. E. and W. R. R. It was first opened many years ago, but reopened by Mr. Pitkin in 1883. It is on the west side of the valley of the Genesee river, and a few rods only west of the track of the B., N. Y. & P. R. R. The principal excavation is rectangular in shape, 109 feet long and 43 feet wide, being determined by the wonderful regularity of the vertical seams. The north-east, south-west and south-east sides are simply joint faces, and the breadth of 43 feet measures the space between two of these vertical seams or joints. A second system of joints runs north-north-east and south-south-west, and dips 80° west-north-west. The *stripping* or covering of earth is nine feet thick on the east side and 25 feet thick on the west side. A part of this *stripping* is of the nature of quick-sand, and slides are very apt to occur, especially in the spring of the year, carrying earth, sand and stone into the quarry. The beds are horizontal so far as can be observed in the quarry. Generally they are separated by thin layers of mud or earth. A vertical section shows the following order in the strata :

1. Sandstone	6 feet 4 inches.
2. Sandstone	4 feet 6 inches.
3. Sandstone	2 feet 0 inches.

4.	Sandstone	1 foot 4 inches.
5.	Sandstone	1 foot 6 inches.
6.	Sandstone	2 feet 0 inches.
7.	Sandstone	3 feet 0 inches.
8.	Sandstone	2 feet 0 inches.
9.	Sandstone	1 foot 1 inch.
10.	Sandstone	1 foot 9 inches.
11.	Sandstone (bored)	2 feet 1 inch.
		27 feet 7 inches.

The quarry beds together have a thickness of 25 feet. The best stone of the quarry has an olive-green shade of color, is fine-grained, homogeneous in texture, and soft enough to dress well and to be easily cut. It is said to harden on exposure to the weather. Some of the stone, which is known as second grade, contains vertical fillings of annelid borings. The equipment of this quarry consists of two derricks for loading stone, one for hoisting stone in the quarry, one Ingersoll channelling machine, one steam drill and one steam pump. A side track runs to the quarry.

The greater part of the stone quarried here is shipped direct by rail to New York city, where it is worked up into house trimmings. The second grade of stone is sent to Rochester, where it is worked at the Pitkin stone yard. There is very little water, excepting in the spring. The caving in on the upper side makes the uncovering expensive. The quarrying season continues, on the average, about seven months. The Portage stone, like the Warsaw blue sandstone, is harder than the Ohio sandstones, but not as hard as the Medina. That they are not as durable as the latter is evident from their composition. The Aldrich Court building on Broadway, New York, has the Portage stone in the trimmings of the first and second stories.

WARSAW, WYOMING COUNTY.—A sandstone known in the market as "Gainesville blue sandstone," has been quarried for many years in the town of Gainesville, and near Rock Glen station, south of Warsaw. It was reopened the past season by the Warsaw Blue Stone Company; and preparations are being made to develop the property, and increase the output. A mill for sawing and dressing the stone is in course of erection. The quarry is on lands of E. E. Farman, and is on the west side of the valley. As opened, the vertical section includes the following members:

1. Earth and stone in fragments.................. 8 feet.
2. Sandstone, with annelid borings....... 2 feet 4 inches.
3. Quarry beds of sandstone, from 18 inches to 4 feet thick.................................. 8 feet.

The ground rises west of the quarry, and new beds come in at top, as the excavation advances into the hill. A side track runs to the quarry from the line of the N. Y. L. E. & W. R. R. The drainage is natural. Steam derricks and a complete quarry plant have been set up. The stone is very fine-grained, harder than the Ohio stone, and has a bluish-gray shade, and is said to retain its color. It has been used for over thirty years in Warsaw and vicinity, for monumental bases and for buildings. The Smith & Perkins block on Exchange street, and the first story of the City Hall in Rochester, and the *Alpine*, on Broadway near Thirty-fourth street, New York city, are examples of its use in construction.

Chemung Group.

WAVERLY, TIOGA COUNTY.—Sandstone is quarried in the vicinity of Waverly by M. L. Bogart and John H. Murray.

Bogart's quarry is about 40 rods from the G. I. & S. R. R. line, and two miles north of Waverly. It is opened in the face of a hill, and the back of the quarry has a height of 80 feet. There is about two feet of overlying earth, on the average. The beds range in thickness from two inches to two feet, averaging about a foot. The stone is blue to gray in color. It has been used in bridge building on the line of the D. L. & W. R. R. Co., and in several business blocks in Waverly, East Waverly and South Waverly. The quarry was opened in 1870.

John H. Murray's quarry is in Chemung county, and one and three-quarter miles from railroad depot at Waverly. The *stripping* is three to six feet thick, and the average thickness of the quarry beds, one to three feet. The stone is a gray sandstone. It has been put into foundations and basements in Waverly. The quarry has been opened thirty years.

ELMIRA, CHEMUNG COUNTY.—There are four quarries near the city and opened in the western face of the hill, which here bounds the valley. One of them is worked by a large force, that of A. D. Simon. It is opened for a length of about 600 feet from north to south, and is back at least 200 feet in the hillside. The maximum height of the face is 100 feet. Earth covers the rock to an average depth of nine

feet. Then the sandstone and shale, in irregularly alternating strata, are found quite to the bottom of the quarry. The heavier beds and the best stone for building, are in the upper 30 feet. And the present quarry operations are on a floor, which is only 40 feet or so below the top. The strata appear to be nearly horizontal; and range from 2 inches to 2 feet in thickness. The rock is conveniently divided by two systems of vertical joints, which run north and south and east and west. The stone is fine-grained and has a gray to greenish-gray color. In working, deep holes are sunk, and by means of large blasts great masses of stone are thrown down. They are broken into convenient sizes for building. The stone is all sold in the rough, and no cutting or dressing is done at the quarry. The larger part of the product is used in Elmira for building and a small part for curbing. The stone averages about a dollar a perch in the city. The plant includes one derrick, a steam-drill, boiler-house and shop, and the teams and wagons for the carting of the stone into the city. A large force of men is employed, quarrying in the warm season and *stripping* in the winter. The quarry is only a mile from the D. L. & W. and the N. Y. L. E. & W. R. R. depots; and is about 150 feet (at top) above the valley.

North of Simon's quarry, and in the same range, three quarries have been opened in the steep hillside, at elevations of 250 to 300 feet above the city. That of John McGreevy has a working face 180 feet long, a breadth of 75 feet and a height of about 40 feet, at the back. There are shales and sandstone here also, and rather more of the former. In the next opening, 50 feet beyond, the working face is 450 feet by 60 feet in height. The vertical section includes earth from 5 to 8 feet thick; shale and a little sandstone intermixed, 5 to 8 feet; then, shales with beds of sandstone from an inch to a foot thick, for 50 feet. About 75 per cent of the mass is shale; and hence waste. About 100 yards to the north there is a third opening, which has a length of 600 feet and a height of 60 feet. Here also the proportion of shale is large. The beds in these quarries are horizontal. Joints divide the rock vertically and make the work of quarrying easy. And much of the stone has the natural joint faces; and they are usually of a dirty-yellow to brownish shades of color. The stone is fine-grained and hard, but not very durable.

These three quarries are not much worked. The amount of waste offsets the advantages of natural drainage and the convenient locations for waste dumps and the nearness to city and railway.

These Elmira quarries are in the Chemung group, geologically viewed.

CORNING, STEUBEN COUNTY.—There are three quarries at Corning, in the valley south of the town, and on the hillside about 250 feet above the bottom of the valley. That of B. M. Payne is on the west side of the valley; and has been opened for a length of 300 yards or more from north to south-west. Its face is 20 to 40 feet high. At the top the earth and shaly beds have an aggregate thickness of 10 to 20 feet. although there is some good stone in these courses. Below, there are 15 feet of beds of sandstone, interstratified with shaly beds. They range from 1 foot to 2 feet in thickness. Two systems of vertical joints, at right angles to one another, are noticed. The stone is grayish-green in color and fine-grained. The quarry was opened in 1855, and has produced a very large amount of stone. It has not been worked during the past season.

John Kelley's quarry is south of and across the road from Payne's quarry. Its working face is 400 feet in length, fronting south-east. The *stripping* consists of earth and shaly rock, together 10 feet. Then come beds of various thickness, from 4 inches to 2½ feet. Some of the shaly rock is interbedded with the sandstone, more or less all the way down to the bottom of the quarry. At the bottom there is a layer 1 foot thick, of soft, blue stone, and underneath it hard, iron-stained rock. The total thickness of workable beds is 30 feet. There is a slight dip in a south-westerly direction. One main system of joints runs north 80° east; a second system runs south 30° east. They are vertical and usually, are open or mud-filled, and at spaces of 15 to 20 feet apart. As the quarry is on the hillside there is no pumping or raising of water. Two horse-power derricks are in use, and the stone are carted to Corning depot, three-quarters of a mile or to the D. L. & W. Railroad line, two miles distant. The Fall Brook Coal Co.'s railroad also is reached at about one mile from the quarry. In the winter season the *stripping* is carried forward, so that the work continues throughout the year. A large amount of stone from these quarries has been used on the Fall Brook Coal Co.'s Railroad line for bridge work. It is sold for common wall work and foundation walls in Corning, at $1.50 per cubic yard, delivered.

H. C. Heerman's quarry is south-east of the Payne and Kelly quarries and on the opposite side of the valley, and about 50 feet above the bottom of the ravine. The opening is large and the *stripping* is thick, as at the quarries above mentioned. The workable

beds of sandstone are from 1 to 3 feet thick, and are interbedded with some shale. It is not worked.

At the south of the town and on the north point of the hill an old quarry has been reopened lately by A. D. Simon, of Elmira, for rip-rap work on canal in Corning.

The stone of the Corning quarries has been used in Elmira, in the Congregational church and in the State Reformatory buildings.

In Corning the old Arsenal; the R. C. church; First Presbyterian church, and the Prot. E. church buildings, are all of this stone. In the Arsenal building, which was erected thirty years ago, the stone shows some signs of age, owing to bad selection. The best example of the Corning stone can be seen in the basement of the High school, and in the basement story of the residence near the public school. In the latter great care was taken to select the large and best colored stone in the quarries.

DANSVILLE, LIVINGSTON COUNTY.—The quarry of Frank Schubmehl. This quarry is one mile north-east of Dansville. The opening has a working face 250 feet long, and the *stripping* is clay loam, two feet thick. The beds lie nearly horizontal, and there are no regular joints. There are six courses or beds, which average 18 inches thick, and ten feet of courses, which are three to six inches thick, making a total of 19 feet of quarry beds. The stone has a bluish-gray color, is fine-grained and hard, but with it there is a soft, argillaceous sandstone, which is thrown out as waste. This quarry has been opened for about 35 years. It is worked in a small way. The product is flag-stone, common wall stone and cut stone. The Sanitarium, the Methodist church, and the Union Free school at Dansville are constructed of this stone.

COHOCTON, STEUBEN COUNTY.—Theodore Whitney quarries stone on lands of S. M. Woodworth, two miles north-east of Cohocton. The *stripping* is clay, and of an average thickness of 4 feet. The quarry face has a length of 200 feet, and in it there are probably 75 beds, or courses of stone, 20 feet of which are workable. These workable courses vary from two inches to six inches thick. The joints of the quarry run north 5° east, vertical, and the stone is light-gray and bluish-gray in color, with a small part of it reddish-brown. The working season lasts six to seven months, and the output is all for flagging, which is used in the adjacent towns.

BATH, STEUBEN COUNTY.—Two quarries of sandstone are worked in the town of Bath. The quarry of W. & Geo. Jincks is one and a half miles north-east of the town. The opening is 300 feet long, and about 20 feet high, with a *stripping* of 5½ feet. The beds are nearly horizontal. About 20 courses are suitable for common wall work, and two courses do for cut stone. The stone is of a light-gray color, hard and fine-grained. The quarry is worked from about the 20th of May until the middle of September. Curb-stone flagging and common, wall stone are here quarried. The Protestant Episcopal church and the county buildings in Bath, are constructed of this stone.

The Miller quarry is three-fourths of a mile north of Bath. It has a face 150 feet long. The vertical section consists of 3 feet of clay, then shales, 5 to 7 feet, below which are workable courses or beds. Some of the thin beds are used for flagging, and these partly pay for the cost of removing the top rock or the shales and clay covering. The cut stone courses are 2 feet 5 inches, and 1 foot 9 inches thick, respectively. This stone is fine-grained, medium soft, and is of a gray shade in color. The quarry is worked three to four months of the year. The principal market is Bath. The Baptist church, erected this year, is of this stone. It sells in the town, delivered, at 50 cents per perch for wall stone, and $4.50 a yard for the cut stone.

HORNELLSVILLE, STEUBEN COUNTY.—Two quarries are opened and worked in the vicinity of Hornellsville. That of Jos. F. Cobb is located one and a half miles south of the town. The quarry face runs 175 feet and 30 feet back. The *stripping* has an average thickness of five feet. The total thickness of the workable beds is 22 feet, of which three to four feet is somewhat slaty and of little value. The dip is very slightly south, about 1 foot in 70. Two systems of joints divide the rock at right angles to one another. They are vertical and run north 50° east, and south 40° west. The stone is of a bluish shade in color, hard and fine-grained, and, in some of the beds, clayey. The adjacent outcrops on the steep hillside show that the sandstone beds are a durable stone. The quarry was opened in 1883. It is worked during the summer season. The product is mostly common building stone, and it is cut for the market at Hornellsville. The Park school-house, recently erected, and the electric light building and several stores and residences are built of this stone.

Two miles south of Hornellsville is the quarry of Morris Powers. Its length is 150 feet, and its height at the back 35 feet. The *stripping* is six to seven feet thick, clay and shales mixed. The bedding, the joints and the stone, in color and in texture, are somewhat similar to what is stated above of the Cobb quarry. This quarry was opened in 1881. The output is small. The price for the stone in Bath is 70 cents per perch.

A sandstone was formerly quarried a little in the town at Greenwood, for home supply.

BELMONT, ALLEGANY COUNTY.—William Storr's quarry. This quarry is a quarter of a mile south-west of the village of Belmont. The *stripping* is two to two and a half feet thick, soil and one and a half to two feet of shales. There are seven to eight courses or beds worked. Two of them are used for cut stone. The aggregate thickness of the quarry beds is 12 feet. The heaviest stone is 30 inches thick. There are two sets of joints, one running north 50° east, and another, which is also vertical, making an angle of 70° with the first. The freshly fractured surfaces are light-blue in color; and when cut it has a light-gray shade. It is rather soft and easily dressed. It is worked from the middle of May to the middle of December, and the principal markets are Belmont, Wellsville and Angelica. Vanderhoef's block in Belmont, besides other buildings, are of this stone. The prices range at about $1.00 per perch for common wall stone to $4.50 per yard for cut stone; the latter, however, at the quarry.

BELVIDERE, ALLEGANY COUNTY.—The quarry of H. Whitcomb. This place is worked by Alfred Dibble, and is half a mile from the Belvidere railroad station. About one-fourth of an acre has been worked over. The gravel loam covering averages about 5 feet in thickness. The strata lie nearly horizontal. One system of joints runs north 15° west, and is crossed by another nearly at right angles, and both of them are vertical. The beds range in thickness from 18 inches to 3 feet 10 inches. The stone is of a light-gray shade in color, medium soft and dresses readily. It is said that this quarry has been opened for about thirty-five years. It is worked in a small way for six months of the year, and produces cut stone for house trimmings, monument bases, horse blocks, hitching posts, etc., and it is used in Belvidere, Friendship, Angelica, and a little of it in Wellsville and Hornellsville.

BELFAST, ALLEGANY COUNTY.—Two miles south of Belfast the only quarry of importance is that owned by Jas. Lang. It is worked to a very slight extent and for the home market chiefly. The Baptist church is constructed of this stone. There are only five or six courses or beds which are worked, of which the lower is the best. The *stripping* is 5 feet thick.

NEW HUDSON, ALLEGANY COUNTY.—Flag-stone is quarried in this town, near the west line of Belfast, by Mr. Searle. It is worked to a limited extent. The stone occurs in thin beds, 1 to 2½ inches thick. They have even and true surfaces ; and are considered the best flagging in this part of the State.

CUBA, ALLEGANY COUNTY.—An extensive quarry west of the village of Cuba was worked many years ago. The rock is a sandstone, and is in the Chemung group.

OLEAN, CATTARAUGUS COUNTY.—The Olean Blue Stone Company quarries a sandstone two and a half miles south of Olean, and near the hilltop, about 700 feet above the Alleghany river. The quarry face has a length of 1,500 feet, and a height of 60 feet, of which there is 20 feet of *stripping*, and 40 feet of quarry beds. The stone is worked into flagging and building material, and is sent to market by rail, being shipped to Olean. The stone is fine-grained, and of a gray to greenish-gray shade of color, although in the market it is known as "Olean blue stone." The quarry was opened in 1878.

JAMESTOWN, CHAUTAUQUA COUNTY.—There are six small quarries in the eastern part of the town, and near the Chautauqua lake outlet. They are from one to one and a half miles north-east of the railroad station. They are worked principally for local supplies. On Allen street, stone is quarried at several points, for cellar walls, and for cut stone, and for house trimmings. These are small openings in the hillside and on rear of the lots.

About a quarter of a mile north-east of Allen street, and on the right bank of the creek, there is an old quarry, whence a large amount of stone has been taken, and which is still worked in a small way. The quarry face measures 40 feet high, including some earth and cap-rock at the top. The upper 20 feet of quarry beds is rather inferior stone, being shaly. The lower beds are thicker, and answer for common walls. About a quarter of a mile beyond, on to the north-east, is the quarry of Ewing, close to the creek. The face is

about 100 yards in length from east to west, and 50 feet high, of which 40 feet is rock. The bottom beds are on an average, one foot thick, and furnish stone for cut work.

The quarry of John McVeigh is on the left bank of the stream, and diagonally across from the last named. Its face looks south, and is 500 feet long and 50 feet high. The strata are horizontal. The upper beds are shaly and irregularly interstratified with thin layers of sandstone, two to ten inches thick. At the bottom, the beds are twelve to twenty inches thick, and they furnish stone for cut work. The top stone is used for common walls and rubble work. The joints or seams are at irregular distances apart. The main systems run north 30° west and south 55° west, the first being vertical, the second dipping steeply north-west. The *stripping* is three to ten feet thick. The drainage is natural, and no machinery is used. The quarry was opened first in 1852. An old opening 100 yards north-east of Mr. McVeigh's, and at the side of the railroad track, is idle.

A more recent opening is that further to the east, on the right bank of the stream, and on the south side of the railroad track, about a mile and a half from the station. Its face fronts north, and has a length of 50 yards, and a height of 40 feet at the west end, and 30 feet at the east end. A section shows drift earth at the top, five to twelve feet thick; then, shales and sandstone, alternating irregularly, being thicker at the bottom, which is nearly on a level with the creek. The beds are horizontal. One system of joints runs south 65° west, dipping 75° to 80° north-north-west; the second, a vertical system, runs north-west. The upper 20 feet are mostly thin beds of shaly stone. The lower 20 feet are strata from 6 to 12 inches thick.

The stone of these quarries is fine-grained, soft and breaks with conchoidal fracture, and has an olive-green color. It has been used in Jamestown and Chautauqua for foundations, and is dressed for house trimmings. It is largely used for retaining walls also. The formation is Chemung.

Other localities in Chautauqua county are in Panama and west of Chautauqua lake; in the town of Clymer, and near the Pennsylvania line; in Westfield, near Lake Erie; and in Laconia, in Pomfret. But at all of them there is much waste in the shape of shales associated with the sandstone beds.

New Red Sandstone.

NYACK, ROCKLAND COUNTY.—Between Nyack and Piermont, on the west shore of the Hudson river, sandstone is quarried at two

points. The quarry of Daniel T. Smith is a half a mile north of Piermont and east of the Northern railroad a few rods. At this quarry the top dirt is about 10 feet thick. The upper beds are somewhat shaly ; then the more solid sandstone comes in thick beds, which alternate irregularly with what are known as "callous veins." Some of the stone has a laminated or reedy structure. The dip is 12° west. About 15 feet in thickness in beds is here worked. Lintels, sills, and a little building stone are obtained. These quarries formerly furnished much stone for foundations in the vicinity, and also some for buildings. A house near the quarry, built in 1768, shows the durable nature of the stone. The Cornelius house also is Nyack sandstone.

The quarry of Nelson Puff, in the same range and in the southern part of Nyack, is worked nearly every season for the local market. The top dirt is heavy and the upper beds are shaly. Below, the stone is solid and thick-bedded.

HAVERSTRAW, ROCKLAND COUNTY.—The sandstone quarries at Haverstraw are in the north-eastern and northern part of the Torne mountain range. They are worked only at long intervals, and for the local market. The stone is rather coarse-grained, and is dark-red in color.

The Demarest quarry, one and a half miles south-west of Haverstraw, is the only one which has been worked of late years.

NOTE.—For the sandstones of the more recent geological formations see pages 22 and 23.

LIMESTONE.

The geographical distribution of the limestone formations in the State and the general reference to the quarries for building stone, which have been opened in them, were given on pages 20–22 of this report. The arrangement of the detailed descriptions of the quarries and quarry districts in the order of the geological series, that is, from the Calciferous, up through the Chazy, Trenton, Niagara, Lower Helderberg and Upper Helderberg, has the disadvantage of separating quarries, which belong together in their geographical and economic relations and of grouping some which are in no wise related, excepting in their position in the same geological horizon. The order of arrangement has been so modified in the following pages as to bring together the quarries in their proper geographical divisions and according to their geological position in these several divisions. It is, therefore, a geographico-geological arrangement. And in it the limestones of the Hudson-Champlain valley are described first; then, the Calciferous and Trenton limestones of the Mohawk valley; followed by the quarries in the belt of Trenton, which runs northwest from the Mohawk to the St. Lawrence; the limestones of the Lower Helderberg formations in Schoharie, Otsego and Madison counties come next; the Upper Helderberg limestones of Onondaga, Cayuga, Seneca, Ontario, Genesee and Erie counties follow; and, lastly, the Niagara limestone quarries of Monroe and Niagara counties.

WARWICK, ORANGE COUNTY.—A blue, magnesian limestone is quarried in the village of Warwick, on lands of Thos. Burt and others. The quarries are in a hillside. The beds are ten inches to four feet thick, and dip west-south-west. The stone is hard, strong and durable. It has been used for foundations largely, and to some extent for dressed house work in the town. The quarries are not constantly in operation.

MAPES CORNER, ORANGE COUNTY.—A blue limestone is quarried in Mt. Lookout, near Mapes Corner, in the town of Goshen, on lands

of the county alms-house and of Wilmot Durland. The stone occurs in thick-beds. It weathers in some blocks to a light-drab to a straw-yellow shade, but it is not unsightly, excepting the variation in a wall due to two or three shades in the several blocks. The locality is worked at irregular times, and by builders who have contracts for buildings. A fine example of the massive appearance of the large, heavy blocks in course work, is to be seen in the Presbyterian church at Goshen. Other structures of this stone are the Methodist Episcopal and Roman Catholic churches in the same town, and the Roman Catholic church in Chester. The quarry was opened about twenty years ago. It is a half a mile from Orange Farm station of the Pine Island Bra. railroad.

NEWBURGH.—Limestone is quarried south-west of Newburgh, near the old Cochecton turnpike, and on the north side of Snake mountain. The Brown Limestone Company has an opening near this road. It is 100 yards in diameter and 30 to 40 feet deep. Although the principal business is the quarrying of stone for lime making, a part of the quarry product is sold for common foundation walls.

West-south-west of the above mentioned quarry, limestone was opened and worked for the West Shore viaduct in the city of Newburgh. At this place the stone is plainly-bedded, and the dip is 40° south 5° east. The stone from this same range was used in St. George's Protestant Episcopal church in Newburgh. It has been used largely for foundation work and for retaining walls also in Newburgh.

Another Newburgh quarry is north of the city and at the side of the river road. It is small and its output inconsiderable.

NEW HAMBURGH, DUTCHESS COUNTY.—A blue, magnesian limestone is quarried by the N. Y. C. & H. R. R. R. Co. at the side of their track two miles north of New Hamburgh. The beds dip westerly at an angle of about 30°. The beds are one foot to eighteen inches thick. The stone is used for bridge work.

KINGSTON, ULSTER COUNTY.—The quarries in the Onondaga Limestone are opened in the city of Kingston on lands of J. O'Reilly, about a quarter to three-eighths of a mile south-west of the Kingston

NOTE. The so-called *Glens Falls marble*, the *Lepanto marble* and the *Hudson coral-shell marble* will be found described under their respective heads in this section on limestones.

armory. The openings are shallow, consisting in the removal of the top strata from what was originally a ledge, projecting above the general level of the surface. The beds dip 16° to 20° in a north-northwest direction. Two well-marked systems of vertical joints traverse the rock at right angles to one another. One runs a little west of north and the other north of east. The beds are from 2 to 8 feet thick. The stone is hard, compact, very strong, and of a bluish-black color, weathering to a pale shade, and on exposure to a buff. The weathered sursurfaces show clay seams, which are from one-sixteenth to one-fourth of an inch thick, and lie in the planes of the bedding. These seams have a yellowish, dirty color, contrasting with the blue, calcareous portion of the mass. Some of the upper layers in this quarry contain black flint or chert, in thin layers; also some scattering pyrite, on the weathered natural surfaces, and occasionally some calcite or quartz. Owing to the bedding and the joints the rock is readily broken into large, rectangular blocks, and thereby the work of quarrying is facilitated very much. The stone is adapted to heavy mason work. Limestone has been obtained at several points in this same lot, from the cemetery on the south-west to Union avenue, near the Kingston & Rondout railroad. The stone for the Poughkeepsie bridge was obtained here. The quarry has been worked by Frank Madden. At the quarry near the City Hall and south-east of Madden's residence, the limestone shows bedding with a dip at a moderate angle to the south-east.

NOONE & MADDEN QUARRY.—Limestone in the western part of the city has been opened by Noone & Madden and worked by them. This quarry is about 200 yards distant from Washington avenue and near Pearl street. It consists in the removal of one or two layers from the exposed, outcropping limestone, over an area of several acres, where the natural surface slopes with the dip of the beds, east-south-east, at an angle of 10°. The well-marked joints, which are vertical, run north 10° east and north 80° west. They are at distances convenient for working, and the quarrying operation is simply in lifting the beds or blocks bounded by these joint divisions. This stone also shows clay seams, in lines parallel to the bed, although more irregular than in the O'Reilly quarries. Some pyrite in scattering crystals is observed in the stone. On weathering, they give the surface a brownish or rusty look. The stone from this quarry has been used for the construction of buildings in the city of Kingston. The clay seams make the stone look unsightly, although they do not

impair the strength or durability, except when the stone is set on edge.

These Kingston quarries are not worked continuously. A large amount of stone was taken from them for the Brooklyn bridge anchorage and piers. It was used in the first bridge over the Hudson river at Albany; in the sea-wall, Battery park, New York; in the dock wall of the Watervliet Arsenal; in locks at Cohoes and Waterford; and in a church at Kingston and in one at Newburgh.

GREENPORT, COLUMBIA COUNTY.—The crystalline limestone of the isolated Becraft mountain, near Hudson, has afforded a large amount of excellent building stone to the city of Hudson almost from its earliest settlement. The ridge is an outlier in the Hudson river slate territory and its structure is that of an open synclinal fold. Its rocks belong to the Water-lime and Lower Helderberg groups. The quarries are on the northern end and on the western front of the escarpment. The older openings, known as the Berridge quarry, are on the northern foot. They are extensive, but are no longer worked. The quarry of F. W. Jones is further south and higher up; and is about one and a half miles from the railroad station (Hudson), and the same distance from the river. The covering of earth is slight where the workings have opened the beds. The dip of the beds in the northern part of the quarry is 10° south-east; in the south opening the dip is 6° to 8° east-south-east. There are two systems of joints of which one runs south-east, vertically. The beds are from 6 inches to 4 feet thick and somewhat uneven on their surfaces. The stone is gray in color, sub-crystalline to crystalline and highly fossiliferous. It is nearly pure carbonate of lime. It is quite easily dressed and takes a good polish, and the polished surfaces have a variegated, reddish-gray aspect. It has been used to some extent as an interior decorative material, principally in Boston, and is known as "coral-shell marble." The Presbyterian church in Hudson is built of this stone. The quarry work is now mainly for supplying flux to blast furnaces on the Hudson. The location is convenient for economical working, as there is no pumping and the *stripping* is light. The stone is carted to the Hudson station. A branch railway line from the river to the quarry is partly graded. The quarry equipment includes channelling machines, steam drills and machinery for cutting and polishing.

SARATOGA SPRINGS, SARATOGA COUNTY.—Blue limestone for common masonry has been quarried at several places in the town, but at no one of them is the business of quarrying continuous. The largest exposure of quarry beds in the town, is north of the Red spring and east of North Broadway about 200 yards. The beds are dipping 8° south and are thick, and the stone is light-blue color. For more than 1,000 feet the ledge has been worked. The upper layers, aggregating eight feet in thickness, are quarried. A second ledge, to the west a few rods, has been worked down five feet.

Three miles west of the town limestone is quarried by Chas. Slade, Isaac Wager, Prince Wing and Jas. A. Lee.

The quarry of Charles Slade is located on the gently sloping side of a low ridge which borders on the north the Washington street road. The older quarrying work was done east of the present site. The working face is 100 yards long from east to west, and is 10 to 20 feet in height. The vertical section shows the following order of succession in the beds, from top downwards:

1.	Boulder-drift earth	3 feet.
2.	Hard, thin-bedded, pale blue limestone,	10 feet.
3.	Dark-blue limestone	2 feet 6 inches.
4.	Dark-blue limestone	1 foot 8 inches.
5.	Dark-blue limestone	1 foot 3 inches.
6.	Dark-blue limestone	1 foot 6 inches.

In the upper 10 feet, and lying immediately upon (3) there is a light-colored bed which is 16 inches thick. The beds dip to the south-west at about 3 feet in 100 feet. The main system of joints is vertical and runs in a south-west course. A system, whose course is at right angles to the first, is vertical also. The joint faces are frequently coated with small crystals of calcite. The top beds are hard and the stone is not easily dressed. The dark-blue stone is softer and is easily worked. Two derricks, worked by horse power, are in use. The quarry now has a natural drainage, but deeper sinking will necessitate pumping. The stone is carted by teams to Saratoga Springs, where it is shipped by rail to destination. The large market is for heavy (bridge) work on lines of the Delaware & Hudson Canal Company. Some of it goes to Saratoga for foundation, retaining walls, etc. This quarry was first opened ten years ago.

Prince Wing's quarry is at Rowland's Mills, and on the south bank of the stream. And the beds here exposed lie above those in Slade's

quarry. A face 400 feet in length and 20 feet in height shows the stratification finely. The beds are thin, and there is some black shale interstratified with the limestone, and the formation is of the Trenton age. This quarry is worked mostly for lime manufacture.

Isaac Wager's quarry is one-third of a mile east of Rowland's Mills, and on the north side of the stream. Here also the beds of limestone dip a few degrees, and to the south-south-east. The covering on the stone is a clay-loam and "hard pan," which varies in thickness from two to seven feet. Then follows the limestone, in beds from 8 to 20 inches thick, for a total thickness of eight feet. The quarrying work moves northward and up the dip plane. Only a few men are employed, and the stone is drawn by teams to Ballston and to Saratoga. It is sold mostly as cut or dressed stone, and for house trimmings and for curbing. It can be seen in the Lathrop houses in Saratoga and in the Wiley building in Ballston.

The quarry worked by Jas. Lee is about 300 yards east-north-east of that of Wager and within a quarter of a mile of that of Slade. It is a small opening and is worked at irregular periods to suit demand. A thin covering of sandy loam here lies on the rock.

SANDY HILL, WASHINGTON COUNTY.—The Sandy Hill Quarry Company's quarries are about two miles from the Sandy Hill railroad station, and a half a mile north-east of the canal. The oldest openings are south of the present working site, and several acres have been uncovered and excavated, but only to the depth of one or two beds of stone. The main quarry is on the north-west slope of the hill, and north of the old workings. The *stripping* on the rock is light, usually not more than one to two feet of earth. The uncovered surfaces show deep, parallel joints or seams filled with earth. These joints, which are thus filled with dirt, run to the bottom of the quarry and through the beds. Their course is south 65° west, and their dip is nearly vertical to the south-south-east. The other joints are vertical. As these seams are quite close together, the rock is well divided into blocks of convenient size for handling. The beds are from one to seven feet thick, and show a dip of less than 5° south. The thickest course, near the bottom is seven feet. The length of the present working face from north-east to south-west is at least a quarter mile; the extreme breadth of the belt quarried over is not less than 100 yards, and the whole depth of quarry beds is 30 feet. The bottom rock is workable stone, and at least 40 feet could be quarried, if the stone

were wanted. In working the quarry, holes of elliptical shape, and four feet deep are put down with a reamer, and then the blocks are split along the line of these holes. The horizontal lifts are made by wedges. The dressing of the large blocks is done on the stone dressing floor at the quarry. A narrow-gauge railway runs through the quarries, with switches to the several parts of the face, and terminates at the canal, a half a mile away. Blocks of 130 cubic feet are conveniently gotten out and shipped. Two stationary engines work the twelve derricks, and a portable boiler runs the steam drills. The stone is of a light-blue color, dense and fine-grained. It is said to weigh 175 pounds per cubic foot. Some of it has a slight ribbon-like appearance, due to the lamination of the beds. The strength of this stone is shown by the report of Prof. Thurston.* The greater part of the stone is shipped over the line of the canal. The railroad carries a small part only, and is over one mile distant. As the quarry is above the natural drainage, there is no pumping. The natural joints, which divide the rock into large, rectangular blocks, make this location a favorable one for quarrying, and the stone is specially adapted to heavy masonry; very little of it is used for common walls and house work. It is being used in the Arthur-Kill bridge on Staten Island Sound, in the bridge piers at Poughkeepsie; and for the base of the Bennington Monument in Vermont; also for the Croton Acqueduct Gate House, New York. A large force of men is employed the greater part of the year, and the output of the quarry (in cubic yards), probably exceeds that of any other in the State.

These quarries are in the horizon of the Calciferous sand-rock, and the stone is a siliceo-magnesian limestone.

Half a mile north-east of the quarry of the Sandy Hill Company, limestone has been opened in a low ledge, for a length of 150 yards, north-east to south-west, and for a breadth of 30 yards. The quarry face is 10 to 20 feet high, and the covering of earth is from one to three feet. The dip of the bed is 8° south-east. One system of seams or joints runs east and west and vertical; a second one at right angles to the first; and another, not so plain, runs south-west. The beds are from one to four feet thick. The stone is hard and brittle, but dresses readily, and the division of the mass of rock by

* According to the published report of Prof. Thurston, the crushing strength of this stone, as shown by his tests, ranges from 18,500 to 28,500 pounds per square inch.

these joints is favorable to economical quarrying. The place is worked irregularly.

GLENS FALLS.—The Hudson river gorge at Glens Falls affords a good vertical section of the Trenton limestones, and two large quarries are opened in its sides. The quarry of the Morgan Lumber and Lime Company, on the Saratoga county side, or right bank of the stream, has the following order of beds from the surface:

1. Black, slaty rock in thin layers	15 feet.
2. Gray limestone	10 feet.
3. Black, thin-bedded limestone	12 feet.
4. Gray limestone	2 feet.
5. Black *marble*	12 feet.
6. Limestone.	4 feet.

The top, slaty rock affords some flagging. The gray stone (2) is used for lime. The thin beds of (3) yield stone for rough work only. It is known locally as "buckwheat" beds. No. 4 of this section is good for cut work. The limestone at the bottom is suitable for heavy masonry, but is not quarried here. The beds dip 5° southward. The main set of joints is vertical and has a course of south-south-west.

This company has a mill for sawing the marble. The lime business has, however, taken the place of the *marble*, and the *marble* beds are now mined for lime making.

The quarry of the Glens Falls company is on the north or left bank of the river and below the Falls. Work has been done here for a length of a half a mile, and in places, back at least 100 feet from the river. The vertical succession of beds from the top is as follows:

1. Gray, thin-bedded limestone	18 feet.
2. Gray-black, thin-bedded limestone	
3. "Jointa lime" beds (three)	
4. Black *marble*	12 feet.

The beds dip 4° south. The joints run south, or a few degrees west of south, and a second set east and west, and both are vertical. They are generally several feet apart, and of great service in the quarrying of large blocks. The gray crystalline limestone at the top is sold in the rough for common wall work, or is dressed for sills, lintels and for house trimming. It is a good building stone, but the quarrying of these upper beds is subordinate and incidental to the marble

business. The *marble* occurs in two thick beds, and blocks of 100 cubic feet are readily gotten out from them. The mass is nearly black, fine-grained and dense. It is hard and brittle, but is capable of being dressed in any style. It takes a brilliant polish, and the polished surfaces are jet black. For tiling it is particularly well adapted, as it does not wear slippery and it retains its color. For sills, lintels, water-tables and general house trimmings also, it makes a first class material. The mill, with four gangs of saws, is at the west end of the quarry and near the bridge. Tiles, shelves, mantels, sills, lintels, coping-stone, wainscoting, billiard table tops and material for all inside decorative work are cut. The interior trimmings of the Equitable Life Insurance building, New York, is one of the best examples of this *marble*. Its market is all over the country as far as Chicago and New Orleans. And it is said that some of the so-called "imported" black marble comes from these quarries.

As the quarry is in the side of the river bank the drainage is natural. Very little blasting is done, excepting in the top rock. The waste (spalls, etc.) are burned into lime. The quarry is a half a mile from the Delaware & Hudson Canal Co.'s (Glens Falls) railroad and at the side of the canal (Champlain feeder).

WHITEHALL, WASHINGTON COUNTY.—The Arana Marble Company (of Rutland, Vermont) has opened a quarry in the Chazy limestone formation, about half way between Whitehall and Fairhaven, and at the side of the Rutland railway line. The limestone is compact, sub-crystalline, and has a veined appearance. The ledge which has been opened is below the water level and close to the track. It has not as yet been developed into what may be called a marble quarry. At present the limestone of a sidehill outcrop, on the same property, is quarried extensively for flux, which is used at Troy.

CROWN POINT, ESSEX COUNTY.—Blue limestone of the Trenton period is quarried at the side of the New York and Canada railroad, about one mile north of the Crown Point station. The stone is fine-grained and suited for building. It has been used at Port Henry, Plattsburgh, Saratoga and points along the railroad, for curbing and some cut work.

WILLSBOROUGH NECK, ESSEX COUNTY.—The Chazy limestone formation (which underlies this neck or low promontory) has been opened in two quarries. They are on what is known as Lagoneer or

Clarke's Point, and on the east side of the neck. About eighteen acres of land is here, in part covered by a thin soil only, or the solid, glaciated rock makes the surface. The quarry of the Lake Champlain Blue stone Company is opened on the line of strike of the rock, about due west, for a length of 1,000 feet, and at the west side its breadth is 250 feet, or an area estimated at three acres. The greatest depth was 25 feet, all above the lake level. The beds dip 6° to 8° north, 10° east; and they are divided by a set of seams or joints, which run north 10° east and by another, which is less regular and persistent, in an east to west direction. The first system is vertical. The beds are from one to six feet thick; and the whole thickness of the workable beds is 16 to 18 feet. The stone is light blue in color, weathering on exposure to a light gray; and, in some of the mass, showing lenticular and roughly parallel-arranged, thin layers of ash-gray in the darker matrix, somewhat like the clay seams of some limestones. There is a dock at the south-east side of the quarry; and the six derricks and engine-house are still in the quarry. The place was worked extensively from 1854 to 1869, by S. W. Clark & Company. Large quantities of the stone went to the capitol at Albany and to the Brooklyn bridge.

S. W. Clark works the quarry about 30 rods west-north-west of the old quarry. The dip and joints or seams and the stone are much like those of the latter. The very regular, vertical joints, the even beds, the absence of any *stripping*, and the convenient location to navigation are the notable advantages of the place.

The Willsborough Neck or "Lake Champlain blue stone" was used in the Reformed church, Swan street, Albany; in the State street Methodist Episcopal church in Troy; in the Brooklyn bridge piers, and in the eastern foundations and sub-basement of the capitol at Albany. From one hundred to three hundred men were employed from 1869 onward for two to three years. At present the force is from six to ten, and the business is ashlar and cut trimmings for buildings, and specially in heavy blocks for bridge and lock work.

PLATTSBURGH, CLINTON COUNTY.—North of Plattsburgh, and in the town of the same name there are several quarries in the Chazy limestone formation which are worked according to the demand for stone. The principal ones are within two miles of the town on the east of the Beekmantown road.

The first one here to be noted is the Pratt quarry, a few rods west

of the same road. It is now owned by Hugh Behan. An area of 500 feet in length, north-west to south-east and half as wide nearly, has been gone over, and the stone removed to a depth of from five to eleven feet. The covering on the rock is nowhere more than one foot thick. The strata dip 7° to 8° easterly, The rock is divided vertically by one marked, smooth joint plane, which runs south 65° east; and by another whose course is north 15° east. They occur at intervals of 18 to 20 feet apart, and are very regular. The stone is of a bluish-black color, hard and semi-crystalline. On weathering it fades to a gray shade. But unless well selected it is apt to show clay seams. A vertical section of the strata at the deepest part of the quarry shows: weathered rock, one foot; then the blue limestone in beds, two feet, one foot, two feet, four and a half feet and two feet thick, respectively, making in all a thickness of 11 feet 6 inches. There is very little water, and no pumping is necessary. Some of the stone from the quarry is used for making lime. A fine example of this stone is seen in the Peristrome Presbyterian church building in Plattsburgh.

On the east of the Beekmantown road, and north-east of the Platt quarry, there is an excavation 100 yards x 70 yards, from which a large amount of stone has been taken. At this place the dip of the strata is very gentle eastward. The rock here is divided by a regular joint, which dips 75° north 5° east, and runs south 85° east, and by a second, running north 15° east, and nearly vertical. At this quarry the courses or beds are: top, two feet thick, second, two and a half feet, and bottom three feet. It is bluish-black, excepting on weathered surfaces, which are gray. This quarry belongs to Mrs. McCready, and is worked occasionally by Peter Lezotte, of Plattsburgh. The stone has a good reputation for heavy work, for which it is admirably suited. It has been used by the D. & H. Canal Company in some of their bridge work on the N. Y. & Canada Railroad line.

One-fourth of a mile north, and on the same side of the road, is what is known as the Fitzpatrick quarry, a small opening, which is worked a part of the year only. The greater part of the product is used as furnace flux, but some of the stone is gray and of a crystalline structure, and when polished merits the name of marble.

North of the latter is Morrison's quarry, in a gray limestone. It furnished most of the stone for the St. John's Roman Catholic church in Plattsburgh, and a part of that used in the Peristrome Presbyterian church.

South of Plattsburgh, three and a half miles, Peter Lezotte quarries a gray limestone on lands of the Burlington Manufacturing Company. There are two openings between the D. & H. R. R. and the lake shore road. The northern opening is 160 yards long, from north to south, and 30 yards wide. The depth of stone does not exceed 15 feet. The beds dip a few degrees easterly. One system of joints runs south 10° east, vertically, and is open. Another, not so plain, is nearly at right angles to the first set. There is one derrick at this quarry. The southern opening has the rock covered by drift earth to a depth of one to three feet. The upper surface is glaciated and solid. The stone is fine-crystalline in texture, and gray to red in color. The dip here is a few degrees to the eastward. The joints are vertical and at convenient distances apart for getting out large blocks. The beds are from three to six feet thick. The depth of this opening is 15 feet. Its approximate dimensions are 80 x 30 feet. The stone is considered superior to that on the north, being more solid. A derrick, a steam pump and one channelling machine are in use. Blocks weighing 17 tons have been taken out of this quarry, and shipped. It is all carted by teams to the lake shore, one mile south-east of the quarry. The principal markets are Plattsburgh and Burlington, Vermont. The first opening was made about fifteen years ago. This stone dresses easily and takes a high polish, and is known in the market as "Lepanto marble."

HOFFMAN'S FERRY, SCHENECTADY COUNTY.—There are two quarries in the town of Rotterdam, Schenectady county, near Pattersonville station, which are worked at intervals. They are opened in the limestone on the hill, 200 feet above the Mohawk river, and a half a mile south of Pattersonville station (West Shore railroad) and the Erie canal. That of James Walker was opened a few years ago, when the New York, West Shore and Buffalo railroad was built. The face has a south 55° east course and a length of 150 yards, and has been worked back 75 feet from north to south. There is from 1 to 4 feet of gravelly, drift earth on the stone. Then the beds which are quarried range from 4 to 18 inches in thickness, and the total thickness of quarry beds is from ten to fifteen feet. At the west end there are two beds, each two feet thick, of gray, semi-crystalline limestone. The dip is to the south-south-east at a small angle. The main joint system runs vertically south-east. The drainage is natural. One horse-power derrick in the quarry serves for loading on wagons,

on which stone is carted to the canal or railroad. The stone is sold for rough wall work, and is cut for house trimmings.

Mrs. Moore's quarry adjoins that of Walker on the east, and with it makes really one continuous opening. The excavation has gone over an area of 100 yards by 50 yards, and the face of the quarry runs a south 20° east course. It is 10 to 15 feet deep. The dip is 3° south-south-east. One system of joints runs south 45° east and a second one, north 20° east, vertically. Here also the top strata are thin, and the thick beds are at the bottom. This quarry has not been in operation for several years past.

Both of these quarries are in the Trenton limestone.

AMSTERDAM, MONTGOMERY COUNTY.—The building stone quarries at this place are one mile from the N. Y. C. railroad station and near the Chuctanunda creek, and from 180 to 250 feet above the Mohawk. The quarry beds crop out in the sides of the creek valley. Ascending northward, the first quarry is that of James Shanahan, which is on the eastern side of the creek, and about 200 yards north of the paper mill. The working face is 200 feet long from east to west, and has in it a thickness of 8 to 12 feet of quarry beds, above which there is drift earth up to 10 feet thick. The beds are from 1 to 3 feet thick, and they dip very slightly to the west. The stone is blue and sub-crystalline. The quarry has one derrick and there is natural drainage. On the west side of the stream, Thos. J. Donlon quarries limestone on the Vanderveer farm. This place was opened first nine years ago. The working face has a length of 500 feet, parallel nearly to the creek, and is 15 to 20 feet in height. The joints run, vertically, north and south and east and west. The beds are from 2 inches up to 2 feet thick; and the bedding surfaces are rather rough and uneven. The stone is a blue limestone, of Trenton epoch. The product goes mainly for common masonry, as foundation walls. Another quarry has been opened north of Vanderveer's for limestone to be used in lime making.

The quarry of D. C. & N. Hewitt is on the left side of the Chuctanunda creek and east of the Rock City road. At the south opening, which was made many years ago, the rock is a dense, blue limestone, like that of Shanahan's quarry. It is the largest and deepest excavation here. The new quarries are about 20 rods northward and on the same side of the road. At this place a large area has been worked over, since two beds only are raised.

The vertical section of the quarries, as stated by Mr. Hewitt, is as follows:

1.	Rough limestone	1 to 4 feet.
2.	Gray stone	6 inches.
3.	Gray limestone	12 inches.
4.	Shelly stone	16-20 inches.
5.	Shelly stone (boring)	6 to 8 feet.
6.	Blue limestone at bottom.	

The top beds are used for lime making. The bed (2) is sold for common building stone, sidewalks, etc. The next bed is the valuable one of the quarry, and is cut into dimension stone, for platforms, steps, sills, lintels and house trimmings. The "shelly stone," near the bottom, is mixed calcareous and argillaceous layers, but is smooth on bed surfaces and breaks *true*. It is used as a common building stone. The blue limestone at the bottom is the same bed which is opened for a thickness of 14 to 18 feet in the old, or south quarry. At the latter the beds are 1 to 3 feet thick. Under this blue limestone there is the livery-looking, black to yellow stone, supposed to be a *cement-rock*. It is 8 feet thick. The dip of the beds is undulating in the quarry; on the west of the road it is a few degrees west. The joints are tight, and in places the stone is "seam-bound." Drainage is natural. Two small derricks answer for loading and moving stone. These quarries are in the Birdseye and Trenton limestone formations.

A large amount of stone used in the foundation of the capitol at Albany was obtained from Amsterdam, and from Shanahan's quarry. Albany, Cohoes and Troy are chief markets outside of Amsterdam.

For home use a great deal of stone is quarried here on the sites for buildings and the excavations for cellars often yield stone enough for the walls.

TRIBES HILL, MONTGOMERY COUNTY.—Henry Hurst & Sons. The eastern end of this quarry is less than 100 feet west of the Tribes Hill station on the N. Y. C. R. R., and between the railroad and the Mohawk river. Its working face looks south-east and trends in a south-west course, nearly 50 rods. The vertical section in the eastern part of the quarry includes the following members:

1.	Soil covering the rock.	
2.	Blue, thin-bedded limestone	10 feet.
3.	Gray, crystalline limestone	$6\frac{1}{2}$ feet.
4.	Gray limestone mixed with blue limestone	7 feet.
5.	Blue limestone at bottom.	

The top beds range in thickness from a few inches to a foot. The gray limestone (3) is sometimes one solid bed, but in places it is divided by a bedding plane, and an upper layer, 20 inches thick, can be lifted off. The strata dip gently toward the north-west. There is at irregular intervals, and generally from 10 to 20 feet apart, a north-west dipping system of joints whose faces resemble those of slickensides. It does not penetrate deeply into the gray stone. The top, blue, limestone, is not dressed, but is sold for common walls or rubble work. It is a good stone for lime making. The gray limestone is fine-crystalline to sub-crystalline, and of a light-gray shade of color, when fine-pointed or bush-hammered. Polished surfaces looks almost like black marble. It is mostly worked into cut stone for house trimmings. For rock-ashlar also it looks well. The blue limestone at the bottom is occasionally quarried and cut for bridge work. But the product of the quarry goes mainly into house work. The drainage is to the river, and no pumping is necessary, as at the south-west end of the opening the bottom rock is on a level with the ordinary water level. Two derricks are in use for hoisting and loading the stone. Stone from this quarry may be seen in the churches in Amsterdam.

James Shanahan's quarry is east-north-east of the Tribes Hill railroad station, about 60 rods. It is on the north side of the Central railroad track, and has a face of 500 feet from east to west, and from 25 feet in height at the east end to a height of 50 feet near the west end. The lowest excavation is 15 feet below the railroad grade and at least 10 feet above the river. The top beds are thin and siliceous in part, and there is some dark-blue, thin-bedded limestone in the upper part. The lower beds are thick and a gray, sub-crystalline limestone. And there is a thickness of 25 feet of beds, from two to four feet thick. The dip is approximately 5° south 65° west. One main system of joints, vertical, runs north 80° west, and a second system, less well marked runs at right angles to it. There are four derricks, and a track into the quarry. The drainage is natural. The product was largely for heavy masonry. As the stone is rather hard it does not dress easily. The quarry has been idle for several years.

At Rocky Hill, three-eighths of a mile north-east of the village, quarries have been worked on lands of Victor Putnam and Henry Hurst. The stone in the upper beds is black and thin-bedded. The dip is gentle to south-west and the excavations are shallow, and in the

top of the south-facing escarpment, and 175 feet above the railroad station. These quarries have been worked at intervals for flag-stone and stone for curbing streets.

CANAJOHARIE, MONTGOMERY COUNTY.—In and near Canajoharie there are three quarries. The oldest of them, that of A. C. & C. H. Shaper, is in the western part of the town, and about 40 rods from the Erie canal and the N. Y., West Shore and Buffalo railroad. The quarry face has a length, approximately, of 1,000 feet, from north-east to south-west, and looks north-west. The quarrying work has moved south-east and south-west, and has reached in places the limits, on account of buildings in the way. The dip of the beds is nearly 10° in places, and to the south-east. A very regular system of joints runs with the strike, in a south-west direction, and at convenient intervals for working. There are no south-east running joints, or seams, except wide spaces apart. The bedding is true and regular, and the vertical section, as given by Mr. Shaper, is :

" 1.	Sand	30 inches.
2.	Gray limestone	12 inches.
3.	Sand	30 inches.
4.	Gray and blue limestone	12 inches.
5.	Gray limestone	12 inches.
6.	Gray limestone	24 inches.
7.	Gray limestone	12 inches.
8.	Sand	30 inches.
9.	Sand	8 inches.
10.	Blue limestone	15 inches.
11.	Blue limestone	12 inches.
12.	Blue limestone	4 inches.
13.	Blue limestone	3 inches.
14.	Sand	10 inches.
15.	Sand	10 inches.
16.	Blue limestone	2 inches.
17.	Gray limestone	8 inches.
18.	Blue and sand	20 inches.
19.	Blue lime and sand	30 inches.
20.	Hard sand block	36 inches.
21.	Blue sandstone	12 inches.
22.	Blue lime	20 inches.
23.	Gray lime	18 inches."

This section shows the thickness of the several strata and their alternations and succession. The chief varieties are blue and gray stone. All of it is hard, but it dresses well and splits *true*. The gray limestone is sub-crystalline. Some of the bottom, sand beds are a little calcareous, and they weather brownish-colored on surface. There are four derricks in the quarry, and steam power is used to work a steam drill and gadding machines. The stone are carted to railroads and canal. The quarry is at least 60 feet above the canal. The stone is used for engine beds, monumental bases, sewer blocks, house trimmings and canal lock construction. Stone from this quarry has been put into all of the churches in Fort Plain and Canajoharie, and in large mill buildings in Utica. Some of it was used in the Brooklyn bridge foundation. It was opened in 1852.

Samuel Morell's quarry is in the eastern part of the town, and 40 rods south of the West Shore railroad. It was opened first in 1883, and reopened in 1885. The covering on the rock consists of soil only. The upper beds are mostly thin, from four inches thick upwards, and a blue limestone; and at about 14 feet down there is a 20-inch bed. Then comes a bed five feet thick, of blue limestone. The following vertical section gives the succession of the strata:

1. Soil covering the rock.	
2. Blue limestone, in beds from 4 inches to 20 inches thick (at bottom)........	14 feet.
3. Blue limestone.....................	5 feet.
4. "Sand course," siliceous limestone ...	2 feet 2 inches.
5. Limestone	1 foot 6 inches.
6. Limestone	1 foot 6 inches.
7. Limestone	1 foot 8 inches.
8. Gray limestone at bottom.	

The dip is to the south-west and at an angle of about 5°. Well-marked joints, vertical, run east to west and north to south, and at distances apart so as to form blocks of good size for heavy work. The working face of the quarry is toward the west and the quarrying moves eastward and to north-east, or up the plane of dip. There is little water, excepting at the bottom. Two derricks, worked by horse power, are in use. Little powder is needed in blasting. The stone dresses well and it is now used largely in face blocks, for the Erie canal locks, three miles east of Canajoharie. This quarry is worked in the winter whenever the demand calls for stone. The

small proportion of waste rock and the natural facilities for economical working out heavy stone are advantages of this quarry.

QUARRY OF RICHMOND & BULLOCK.—This quarry is in the north face of a natural escarpment, one mile east of Canajoharie, and at the side of the canal and the West Shore railroad. It was opened the present season (1887). The bluff is nearly vertical for 70 feet, up from the Mohawk flats, and then it slopes steeply for 30 feet to the top. The upper part of the bluff is now being cleared off to the rock, and preparations are being made to quarry the beds from near the tcp, down for a distance of 25 to 30 feet, and to a level which is 60 feet above the valley. These top courses of stone are thin and are blue limestone, which dips gently south-west. The main system of joints runs vertically, in a south-west direction at intervals of 10 to 12 feet. One derrick is placed on the upper level and a second one stands at the side of the railroad track. An iron-shod chute allows the stone to be sent down to the track level. Near the foot of the bluff there is a ledge of fine-grained, reddish-colored rock, which is hard, and capable of polish, and which appears to be adapted to ornamental work. As it is siliceous it will resist weathering better than the limestone.

The Canajoharie quarries are in the Calciferous formation, and that of Richmond & Bullock is near the bottom and lower, geologically than the quarries in the town.

FORT PLAIN, MONTGOMERY COUNTY.—The Birdseye limestone was formerly quarried quite extensively at this place, for local market. A small quarry at the north side of the New York Central railroad track, and about 100 yards east of the station, is the only one now in operation. The beds are thin and are dipping gently, south-east.

PALATINE BRIDGE, MONTGOMERY COUNTY.—There are two quarries in the limestone at Palatine Bridge, on the north side of the Mohawk river. The westernmost quarry is that of S. L. & A. B. Frey. It is north of the Central railroad tracks about 20 rods, and little further from the Frey mansion. It was opened three years ago. Nearly a half an acre of territory has been worked over in the excavation. The covering of boulder earth on the stone is from a thin soil layer to six feet in thickness. The stone is a blue limestone, but there is much variation from bed to bed, and some of the beds are quite sandy. At the bottom there is a thick bed of gray limestone, which

does well for cut work. The blue stone is put into heavy masonry and common, wall work. The dip of the strata is a few degrees and to south-west; and the vertical joints run in the same direction. The drainage is natural; and the bottom of the quarry is 20 feet above the railroad track. Three derricks are in use. The stone is carted by team to the canal or to the Palatine Bridge station; and a large amount has been quarried here during the past season. The stone of this quarry may be seen in the East avenue Presbyterian church of Schenectady.

Wm. Johnson of Palatine Bridge opened a quarry on his lands in the north-western part of the village the past season.

These quarries are in the Calciferous formation.

LITTLE FALLS, HERKIMER COUNTY.—The Calciferous sandrock is quarried at several places in and near this town, in the bluff to the north. Three of the quarries are near one another, north-east of the town and a half a mile from the Central railroad station. At the most western quarry the face is 100 feet long and 20 to 30 feet high. The beds are nearly horizontal and from one to two feet thick. The stone is light-gray shade and is fine-grained. It is used for common wall work.

The next quarry to the east is 300 feet long, from east to west, and is 55 feet high, and has in it 30 beds. One main system of joints is vertical and strikes north-west. The stone has a bluish-gray shade of color, weathering light-gray on exposed edges. It is fine-grained. At the top the beds are somewhat decomposed, and the stone is rotten, and of little value for building purposes. The lower beds are 1½ to 2 feet thick.

The next quarry, to the east 20 rods, has a length of 300 to 350 feet and a maximum height of 40 feet. At this quarry also, the top strata are much weathered and disintegrated, and of no value as building stone. It does not appear to have been worked in some time. The stone resembles closely that of the quarry next it on the west. Both of these old quarries are in the rear of the street and 200 feet from it. The stone from them is used for cellar walls and retaining walls and for street curbing. The gneissic rock outcrops are to the south, less than 300 feet away, but on lower ground.

One and a half miles north-north-west of Little Falls, on the Wilcox property, the Trenton limestone is quarried by Hanlon Brothers. The locality is 300 to 400 feet above the Mohawk valley and a quarter of a mile east of the school house. A thin layer of soil

lies upon the rock, which at the top is thin-bedded and highly fossiliferous. This thin-bedded stone is thrown out on the dump as waste. The beds which are quarried, are from four inches to three feet thick, and consist of the Birdseye limestone. They are nearly horizontal. The joints run regularly in a north and south direction, and east and west, and vertically. The total thickness of the quarry beds is 18 feet. From the bottom of the quarry the limestone has been found to run down 10 feet to a sandstone. The stone is largely sold for curbing, and some for flagging, and a little for common wall work. The top rock is either given away for walls or is sold at rate of one dollar a ton in the town. There is little water excepting at the bottom, and no pumping is necessary.

NEWPORT, HERKIMER COUNTY.*—There are three quarries in the limestone worked in this town. They are owned by Waldo Sherman, Wm. Reynolds and John O'Connor. All have been opened within three years. They are from one to one and a half miles from railroad.

HOLLAND PATENT, ONEIDA COUNTY.—Martin Olin and J. G. Hilledge have quarries in the Trenton limestone formation at this place.

PROSPECT, ONEIDA COUNTY.—There are four quarries opened and worked on the West Canada Creek, between Prospect and Trenton Falls.

The first quarry south of Prospect is that of Evan S. Thomas, on the right bank or Oneida county side of the stream. The rock is covered by soil and subsoil only. The strata are nearly horizontal, and range from 4 to 16 inches in thickness. Seams, or joints, traverse the rock in a nearly north to south course. The quarry beds have a total thickness of 20 feet. The bottom of the quarry is perhaps 50 feet above the creek, and the drainage is that way; and the waste and *stripping* are thrown off the edge of the bluff into the gorge. The stone is gray, sub-crystalline, and is rather easily dressed. The output is carted to the R. W. & O. railroad station, one and a half miles away and shipped to Utica, Rome and other points. Stone are in the U. S. Government building at Utica; R. C. church buildings at Little Falls and Sandy Hill; M. E. church at Herkimer, and in several church buildings at Norwich. The quarry was opened in 1852.

* The locality was not visited.

Across the creek and on the Herkimer county side, Edward Callahan quarries limestone. The covering, strata and situation are quite like those of Thomas's quarry. The vertical section includes the following members:

1. Earth, covering stone	1 to 3 feet.
2. Thin and irregularly bedded, dark-blue limestone	7 to 8 feet.
3. Quarry beds (12 in., 14 in. and 5 in.)	2½ feet.
4. Calcareous shale ("shelly bed")	1 foot.
5. Quarry beds (10 in., 6 in. and 8 in.)	2 feet.
6. Slaty rock ("big scale")	2 feet.
7. Quarry beds (6 in., 6 in., 5 in., 5 in., 10 in. and 11 in.)	3½ feet.

The strata dip at a small angle northward. A close seam or joint, nearly vertical, runs north to south, and another, but open, courses in a general east and west direction. These seams assist in quarrying, and a little powder is used to break down top rock only. By means of plug and feather wedges the blocks are split apart, and the thickness determines the use. Platforms, flagging, lintels, sills, and water tables are cut. In some of the thicker beds there are shaly laminæ, or parts, which on weathering, disfigure the stone by their dirty yellow color in the darker-colored mass. The distance to railroad is about one and three-quarter miles. Utica is the principal market, and Mr. Callahan has a yard in that city.

The quarry of George & Griffith (of Utica), is on lands of Mrs. John S. Clark, one mile south of the last noted, and on the east or left bank of the creek. The covering of earth is here also thin, and the beds are nearly horizontal, and eight courses or beds are worked. They are from four to sixteen inches thick. The stone is shipped to Utica as the main market. This quarry was opened in 1860.

The quarry of H. & L. N. Jones is on the west or right bank of the creek, one mile south of Prospect village. It has been opened for twenty-five years, and worked by the present firm for nine years. The vertical section here is as follows:

1. Earth	2 feet.
2. Irregularly bedded limestone	3 feet.
3. Quarry beds (five)	6 feet.
4. Shaly limestone	4 feet.

The bedding at this quarry runs unevenly, and the top strata cannot be followed throughout from end to end. The beds lie nearly

horizontal, probably dipping very slightly, southward. An open seam or joint, somewhat irregular, runs across this quarry and across the creek to the opposite quarry in a course north 83° east. These seams are wide apart. A set of tight seams or joints, nearly vertical, runs south 17° west; and these latter are of great service in the excavation of the stone. The average thickness of the quarry beds is from 10 to 12 inches, but at the south end there is one that is 2 feet thick. Northward the same bed splits into two layers. The top stone is sold or given away for foundation and common walls. The quarry beds are worked up into cut stone, and mostly for house trimmings, but a part is used for monumental purposes. The principal market is Utica, and recently some of this stone has been used as rock-ashlar for building fronts in that city.

On account of the light covering of earth on the rock; the ease with which the waste, cap-rock and dirt is removed; the natural drainage and the convenient thickness of the quarry beds for cut stone, these Prospect quarries are worked with economy and profit. The stone is carted by teams to Prospect station, from one to two miles distant from the quarries. About 20 men are employed in the four quarries. The stone is known as the Trenton gray limestone. It has been employed very largely in Utica for ax-hammered, bush-hammered and fine-pointed house trimmings, and also for platforms and curbing. A single objection to it is in its fading on long exposure to the atmosphere.

TALCOTTVILLE, LEWIS COUNTY.— Limestone was formerly quarried to a considerable extent near Talcottville, on the Sugar river. There is said to be a fine exposure of rock along the stream and of excellent stone for heavy masonry. The locality was not visited.

Other quarries in blue limestone are in the same town of Leyden. The strata are thick, and are suited for heavy work. And stone has been quarried there in the past year for canal lock construction.

LOWVILLE, LEWIS COUNTY.—Two quarries are here opened in the blue (Trenton and Birdseye) limestone.

Hiram Gowdy's quarry is a few rods east of the railroad and a quarter of a mile south of the station. The face, as worked, is about 250 feet long from north-east to south-west, and it is 10 feet high. The stone is covered by soil only. There are three beds, which are two to three feet thick, and they lie nearly horizontal. The mass is traversed by one vertical system of joints, which runs east-north-east,

and by a second system which is more irregular. The stone is dark-blue, almost black, hard and dense. Dressed surfaces do not show the sharp contrast with the natural fracture surface like the Prospect stone. It is suited to heavy masonry; and it has been used in the new bridge of the R., W. & O. R. R., over the Central tracks at Utica. The quarry is above the natural drainage into the creek. One derrick does the hoisting.

Luman Carter's quarry is on the right bank of the creek and a half a mile south-east of the railroad station. The face of the quarry is nearly parallel to the creek, and about 400 feet long and 80 feet in height. The stratification is nearly horizontal or with a slight dip to the north-west. The seams or joints run vertically east and west, and about twelve feet apart; others are less regular. These seams help in the extraction of large blocks. The top strata are of a light-blue stone, and the surface, when uncovered, shows beautiful glacial lines in a north-west and south-east direction. The upper beds are heavy and answer for bridge work; under them the thinner courses, or beds, work up readily into dimension stone for house work. The rough stone of the more irregularly bedded part of the quarry is worked into rubble or common foundation walls. Lowville is the principal market. But the heavier stone go into bridge piers and heavy masonry in all parts of the county, and some to Utica. The beds are all above the creek, and there is no pumping needed.

The Lowville stone is used for bases in cemetery work. It looks well when fine-pointed, but it is not so easily dressed as the Prospect stone, and is much darker in shade, both dressed and in the rough.

THREE-MILE BAY, JEFFERSON COUNTY.—At Three-Mile Bay, the limestone outcrops are so near the surface that much stone is obtained at many places for local needs. The only quarry, which is worked steadily, is that of John J. Barron, one mile south of the village, and a half a mile from the railroad station. It is practically on the lake shore, as the dock is only 100 yards or so west of the quarry. The depth of water off the dock at this point is 15 feet. The place was first opened nearly forty years ago, and a large quantity of cut stone for heavy work was gotten out. It was reopened fifteen years ago. The excavation has a length of 200 yards from north to south, and a breadth, back, of 40 yards. The beds dip about 7° to the east. The main seams or joints are dirt filled, and run in a south-westerly course, irregularly, and 5 to 10 feet apart. The surface stone is thrown off as waste, although good for lime. The beds are: first, the top, 28

inches thick; then, one 18 inches thick; a third one 6 inches thick; and the bottom, 7 inches. These two lower beds alone are worked for cut and dimension stone, and the heavy beds at the top go into flagging material. The stone is sold at the quarry at 25 to 40 cents per square foot, according to size. The lower bed is cut for coping 10 inch and 7 inch, and is fine-pointed and sells at about $1 a running foot. The product of the quarry, as now worked, is largely put into the market for house-trimmings. A part of it, however, is used for cemetery work.

Nearer the village and near the water the top beds are well exposed on the surface; and Barron has opened the locality and worked a 10-inch layer, which appears to be equivalent to the 6-inch and 7-inch layers at the southern quarry. A few rods north-east of Barron's house there is an abandoned quarry, where the beds are thick, and the stone strong and solid; and it was once worked for bridge stone. The drainage at these openings is natural, and there is no machinery employed. The markets for the stone are Watertown and points on the lake shore.

CHAUMONT, JEFFERSON COUNTY.—The following quarries are opened in and near the village of Chaumont:

Copley's quarry, worked for lime; the quarry of Belden, Johnson & Company, of Syracuse, on the shore of the lake; the quarry of Adams Brothers; the quarries of Du Fort & Son, on land of H. Copley.

The quarry of Belden, Johnson & Company, on the bay, has a working face of 500 feet in length from north-east to south-west, and a breadth of 100 feet, at least, at the eastern end. The main joints run, vertically, south 82° west and north 25° west. The strata dip slightly, westward. The upper beds of rock are somewhat irregular, and, in part only, available for building stone. It answers, however, for common walls, and is 8 to 9 feet thick. Under it there are four feet of thick beds for cutting and dressing. Next below, follows a thin and irregular layer, a foot thick; then, the gray, sub-crystalline limestone, in beds, 6, 6, 12 and 8 inches thick, or in all, 2 feet 8 inches. At the west end the dip carries the beds below the lake level, necessitating some pumping. This quarry is worked at intervals by Adams Brothers.

The main quarry of Adams Brothers is on the bay shore, in the village. The quarry face is at least 600 feet long (from east to west),

and is 17 feet high; and the order of the strata, from the top is as follows:

1.	Dark-blue limestone	8 to 10 feet.
2.	Gray limestone (32-inch layer)	2 feet 8 inches.
3.	Gray limestone (16-inch layer)	1 foot 4 inches.
4.	Gray limestone	4 feet.
5.	Black limestone, ten feet above the water level of lake.	

The seams or joints in this quarry are remarkable for their regularity, and they are a great help in quarrying. One set or system runs south 80° west, and dips 80° to 85° southward; a second system runs south 10° west, vertically. They are from five to fifteen feet apart. The dark-blue stone of the upper part is burned into lime, at the quarry kilns. The gray stone of the 32-inch and 16-inch courses or beds, are dressed for lock-facing stone, or are cut for monumental work. The gray limestone of the bottom (4, of section) is cut into sills, lintels, water tables, etc., for house trimmings. This quarry has been opened four years. An example in construction, of this stone, is seen in the Protestant Episcopal church building in Watertown. The quarry is within a half a mile of the R. W. & O. R. R. station.

South of the village, and on the east side of the little bay, are the quarries of Davis, and Du Fort & Son. The Davis quarry is about a quarter of a mile from the village. Blue limestone is seen at the top, then the 32-inch bed and the 16 inch bed, and under them the gray limestone. An area of 600x200 feet is here opened and worked over. This quarry is run at intervals.

DU FORT & SON'S QUARRY is south of the last named, and a half a mile south of the village, and three-quarters of a mile from the railroad station. It is on the shore of the lake; and at the dock near the quarry there is a depth of 12 feet of water. The several beds are shown by the following sections:

1.	Blue limestone	3 feet.
2.	Gray limestone (32 in. layer)	32 inches.
3.	Gray limestone (16 in. layer)	16 inches.
4.	Gray limestone	10 inches.
5.	Gray limestone	8 inches.
6.	Gray limestone	6 inches.
7.	Black limestone	18 inches.
8.	*Shelly* beds, at bottom.	

The dip of the beds is very slightly west, as shown by their passing below the level of the water 200 yards west of the quarry. The main joint system runs south 75° to 80° west, but is not so open as that in the quarry of Adams Brothers. There are two derricks for hoisting stone. The drainage is natural, into the lake. Powder is used for blasting off the top, blue stone, which is thrown away. The 32-inch and 16-inch courses are now quarried for lock construction on the Erie canal. The 10-inch layer is worked into sills, lintels, etc., for house trimmings, and the lower beds are used for flagging. The stone from this quarry can be seen in H. Copley's office in the village. At the present time the product is largely used for Erie canal lock construction.

These Chaumont quarries are, geologically viewed, in the Black river and Trenton limestone. The stone of the thick courses is strong and well adapted to heavy wall work. And a great quantity has been sold for canal and bridge construction. It sells at $9 to $13 per cubic yard. The gray stone for house trimmings brings 50 to 60 cents per square foot. About forty men are employed in the several quarries, and the work continues all the year or whenever weather permits. As they are all convenient to lake and rail the markets are reached easily and cheaply.

Limestone is quarried near Brownville at the side of the Cape Vincent Branch railroad, occasionally, and for local use.

At Watertown the limestone is finely exposed in the gorge of the Black river. The strata dip at a small angle westerly. The 32-inch and 16-inch beds of the Chaumont quarries are thinner here. The gray stone underlies them. Up the stream and easterly the dark-colored, knotty limestone is in force.

OGDENSBURG, ST. LAWRENCE COUNTY. — Much limestone has been used in building in this town, and the larger part has been obtained from local quarries, in the Chazy limestone formation. The elegant town hall and St. John's P. E. church are substantial and beautiful examples of the stone, which is found in the valley of the river, in the town. The quarry-site is built over, in part, by the Hub factory. The quarry, which is now worked for local supply, is on the Oswegatchie river, about two miles south of the town.

NORWOOD, ST. LAWRENCE COUNTY.—Robert Murray has a quarry in the town of Norfolk, one and a half miles from Norwood station of the O. & L. C. R. R. line. It is in the blue limestone. The beds

are from five to eighteen inches thick. The stone is dark-blue and compact. It has been used for buildings ; and the following are structures in which it can be seen : Presbyterian churches at Malone, Waddington and Canton; Roman Catholic church at Hogansburg ; and St. Lawrence county court house, and clerk's office, at Canton.

SCHOHARIE, SCHOHARIE COUNTY.—East of the village of Schoharie, limestones of the Lower Helderberg and Water-lime groups afford excellent building material, and some which is suitable for monumental or decorative work. The quarries are small and are not worked, except when stone is wanted for home use. The black, tentaculite limestone is notable for its compact texture and its capacity to take a high polish.* It is not opened as a marble. Z. J. Brown, of Schoharie Valley, has used some of it for cemetery work.

A good example of the enduring quality of the blue limestones of the Lower Helderberg group, as they occur in the Schoharie valley, is the old Reformed Dutch church and stone fort (now State property), one mile north of the village of Schoharie Valley. Although built in in 1766, the walls are still firm and the stone are not faded nor weathered even on the sharp edges and corners of the blocks.

HOWE'S CAVE, SCHOHARIE COUNTY.—Two quarries have been worked in former years for both building stone and for the hydraulic limestone. The former overlies the latter in the face of the escarpment, on the west side of the valley. The upper beds are known as the "gray stone," and are 15 to 20 feet thick. This gray limestone checks and does not polish, and is best suited for heavy masonry. The tentaculite, or blue limestone under it, is equally hard and solid, and dresses well under the hammer. It is a good building stone. Some shaly beds are interstratified with the more solid and firm stone, and hence there is some waste. The stone quarries are above the cement-rock mines or quarries. They have been idle during the past year

COBLESKILL, SCHOHARIE COUNTY.—Wm. Reilly's quarry is a half a mile north-west of Cobleskill, and in the Upper Helderberg limestone formation. It was opened about 25 years ago. The quarry is 200 feet square. There are 30 feet of workable beds or courses, overlain by *stripping*, seven to eight feet thick, and ranging from five inches to two feet thick. The dip is only about 2° south-

* The beautiful bl ck of this limestone, or black marble, in the State Museum suggests its use, and the desirability of further exploration to test the locality.

ward. The seams or joints are south 10° west, vertical, and a second set at right angles to the first, and also vertical, but not as regular or uniform. At the bottom there is a thin-bedded, blue limestone, and under that a water-lime rock. Large-sized blocks are readily obtained. Both gray and blue limestones are found, but the greater part is gray and sub-crystalline in texture. It is not as hard as the blue stone, and is more readily dressed. Stone are sold to Albany, Binghamton, and more in Cobleskill. The Methodist Episcopal church in Amsterdam; the German Methodist church, Clinton and Alexander streets, and the R. C. church in Central avenue, Albany, are of this stone.

SHARON SPRINGS, SCHOHARIE COUNTY.—There are two limestone quarries at Sharon. That of C. T. Smith is at the upper end of the village, and at the north side of the street. It is opened in a side-hill. The strata dip at a small angle to southeast; very regular joints run north-east and south-west, and a less persistent set at right angles to the first. The bedding is well marked and regular. The stone is compact and hard, but is said to dress well. It has been used in structures in the village (houses and the Protestant Episcopal church) and for house trimmings. The thin beds answer fairly for flagging and crosswalk stone. The formation is Lower Helderberg limestone.

Another quarry in the place is that belonging to Mrs. Daniel Norton. Francis C. Mallett and Mrs. Jefferson Smith also own small quarries in the vicinity. They all do a local business.

CHERRY VALLEY, OTSEGO COUNTY.—For the local use the Onondaga limestone ledges, which crop out north of the village, furnish an excellent stone. There is no regular quarry, although the amount of stone construction in the place is comparatively large. The stone is light-blue in color, and in thin beds. It dresses well. The Presbyterian church, the Belcher House and other buildings show it to advantage.

SPRINGFIELD CENTRE, OTSEGO COUNTY.—The Onondaga limestone has been opened and quarried to some extent in the McCabe quarry, one mile north of Springfield Centre, and near the Herkimer county line. It was opened in 1869. The beds dip 3° to 4° south 35° west. They range from one to two feet thick. Blocks of large size are readily obtained. The stone was used in building the house of Edward Clark; in the Otsego county jail; and in the Fenimore House, in Cooperstown.

Another quarry in limestone in the same town is at East Springfield, on the road to Cherry Valley.

PERRYVILLE, MADISON COUNTY.—The Onondaga gray limestone is well exposed in the creek gorge at Perryville; and it was first opened for building stone, more than 60 years ago, at the time of the Erie canal construction. There are now three quarries in the place, which are worked to some extent. They belong to the E. C. & N. R. R. Company, O. F. Britt, and the J. T. Smith estate.

ORISKANY FALLS, ONEIDA COUNTY.—M. Juhl quarries limestone for building and for furnace flux about a half a mile from the N. Y., O. & W. railroad station, at this place. A great face of stone is opened and is reached by a switch from main line into the quarry. The covering of earth is 2 feet thick. Then follow: the blue limestone, 10 to 30 feet thick; and next, in beds ranging from four inches to two and a half feet thick, blue limestone suited to building. The quarry was first opened at the time of the Chenango canal construction.

There are quarries at Waterville and Cassville, also in Oneida county, and on the line of the Delaware, Lackawanna and Western railroad. They are in the Corniferous limestone.

MANLIUS, ONONDAGA COUNTY.—Loomis' quarry, at Manlius, is in the gray, Onondaga limestone. It is worked for monumental stone and for house trimmings. The locality is on the Syracuse, Ontario and New York railroad line.

The JAMESVILLE quarry is in the same range, and it is worked for bridge work mainly. The Syracuse and Binghamton railroad line runs through the place.

SPLIT-ROCK QUARRIES, ONONDAGA COUNTY.—These quarries are in the town of Onondaga, five to seven miles westerly from the city of Syracuse. They are opened in the north edge of the Upper Helderberg escarpment. The most eastern opening is that of Hughes Brothers, on the Fay place, five miles from Syracuse, and on the south side of the road, and about two and a half miles east-south-east of the main group of quarries. It was opened in 1877. The earth covering does not average more than one foot in thickness. Thus far only the top course has been quarried, which is 2 feet 6 inches thick. The stone is gray, crystalline, and softer than that of the quarries on the west. It dresses well and makes a good material for house work.

It is worked for lock stone mainly. There are two derricks at the quarry. The stone has to be carted to Syracuse.

The Shonnard Hill quarries are opened and worked by J. J. McLean, Jas. Connor, Cornelius Crowley, and Hughes Brothers.

The Hughes Brothers' quarry, at the south, is the oldest and the largest of this group. The locality has been opened for many years. Two courses or beds only are worked, and together are about 4 feet thick. At the bottom there is a gray limestone, which is seamy. These seams or joints run east and west and dip south, steeply. Blocks of very large size, limited only by the capacity for handling, can be obtained here. The stone is carted to Syracuse, and dressed at the yard of Hughes Brothers.

Crowley's quarry is separated from the above mentioned by a property line only. The beds are horizontal; and the stone is very similar to that of the Hughes Brothers' quarry.

The quarry of James Connor is north-west of that of Crowley's and north-east of that of Hughes Brothers. Along the east-west running face of the ledge, where worked, the top earth is only one foot thick, and the top, quarry bed 2 feet thick, and the second course 2 feet 8 inches. The bottom is a gray, seamy limestone, which is partly used for building purposes. There are two derricks here. The drainage is natural. The blocks are carted to Syracuse, and they go into canal locks and house trimmings.

J. J. McLean's quarry is north-west of the last described, and about 500 feet distant. The earth covering of the strata here is 1 to 2 feet thick, and the strata are horizontal. One main system of joints runs east and west. Only a few feet, at the top, are quarried for lock construction. One derrick is used.

The total area quarried over in these several openings on Shonnard Hill is at least ten acres. About fifty men are employed on an average. There is no water to be raised and no pumping, and the work continues during the whole year. The stone is carted to Syracuse, although the railroad line is within two miles to the north. The formation is known as the "Onondaga gray limestone," and the geological horizon is that of the Upper Helderberg period.

To the east of this group of quarries, as now opened, and a few rods only from the roadside, is the quarry of Cornelius Crowley. The beds at this place dip 5° to 7° north-east. Two courses or beds only are taken off and they are used for canal locks. The bottom is gray, seamy rock. Still further to the east, and north of the road a

quarter of a mile, M. Degnan has opened a quarry. The gray limestone and associated strata are similar to those at the Shonnard quarries. To the north-east, and across the gulf from the last mentioned locality, is the abandoned quarry of Wm. Liddy.

The Splitrock quarries were worked actively at time of the building of the Erie canal, and many locks on it were of the Splitrock gray limestone.*

ONONDAGA RESERVATION QUARRIES, ONONDAGA COUNTY.—South of Syracuse and on the Oonondaga Indian Reservation, gray limestone is quarried by five parties, all within a range of three-eighths of a mile from north to south. They are in the north-east corner of the Reservation, and are worked at a nominal rental paid to the State. At the north-eastern end of this group of openings is Hughes Bros. quarry. Going south, the next adjoining, is that of John Kelly, Jr., and then the quarries of Patrick McElroy, Wm. Crabtree and D. L. Storrier. The quarries of Hughes Bros., Kelly and McElroy form one continuous opening, which has a length of 250 yards from north to south. The quarry face consists of a wall of rock running in a zig-zag course following the joints or seams. At the north end the beds are horizontal or may dip slightly east-south-east. In McElroy's quarry the dip is to the south-east and at an angle of 20°. The seams or joints run nearly due east and west; and another set, less regular, north and south. A vertical section of the strata in Hughes Brothers' quarry has: blue limestone (cherty) ten feet; blue limestone, one foot; gray limestone, six feet, and gray limestone at the bottom. The covering of earth on the rock is rarely more than a foot thick. The joints are plain in the blue stone, but less marked in the gray. The bottom bed, four feet thick, has tight seams or is "bed-bound," and is not worked. A vertical section at McElroy's quarry shows: rock, with earth mixed, 6 feet; blue limestone, 20 feet; gray limestone, 7 feet; and gray limestone at the bottom, 5 feet. The blue limestone is in beds or courses one to two feet thick, and is usually separated by thin layers of shaly rock. It contains much chert. This blue stone cannot be dressed, and only a small part of it is used, for common walls; and for this purpose some of it is carted to Syracuse, but owing to the expense of carting it, the greater part is left on the dump in the quarry. The removal of this *stripping*, of blue limestone, makes the working

*There was then a population of 5000 people at Splitrock. The old stone tavern, a massively built structure, and 50 years old, is all that is left of the town, and a proof of the durability of the stone.

of this quarry costly. Only the superior value and quality of the gray limestone compensates for the heavy work of *stripping*.

From McElroy's quarry it is 200 yards south-south-west to Crabtree's. This quarry has a face of 200 feet in length. Boulder-drift earth, up to 10 feet thick, covers the blue limestone, and with the limestone, makes a total thickness of 20 feet of *stripping*, before the gray stone is reached. The same gray bed, with tight seams, is seen at the bottom of the quarry.

Storrier's quarry is about 20 rods south of Crabtree's. It was opened three years ago. The beds dip east-south-east, slightly. At the west side the drift earth lies immediately on the gray bed, which is four and a half feet thick. The blue, shaly limestone comes in at the top as you go eastward.

The gray bed seems to run out southward, and beyond Storrier's quarry. The water in these Reservation quarries is raised by siphons and carried over to a stream in the valley on the west side of them. They are worked more or less all of the year, or so long as the weather permits. The stone is all carted by teams to Syracuse, six and a half miles distant. It has a gray color, crystalline texture, and in the market is known as "Onondaga gray limestone." It is a strong and solid building stone, and does not show the black seams, marking some of our limestones, nor *clay seams*, so common in nearly all of the Mohawk valley and Hudson-Champlain valley limestones. When fine cut, the color is light-gray, approaching the best of the Maine granites, and in pleasing contrast to the rock face stone, which is much darker in shade. It has been the principal building stone in Syracuse, and there are many fine structures in that city which are of it. Notable among them are the new U. S. Government building, Hall of Languages, Syracuse University, Onondaga County Savings Bank building, St. Paul's P. E. church, St. Mary's R. C. church, and the May Memorial church. A large amount of this stone has been put into lock facings on the Erie canal, especially east of Syracuse. It has found a ready market in Oswego, Binghamton and other cities in the central part of the State.

UNION SPRINGS, CAYUGA COUNTY.—The Onondaga limestone is opened in a group of quarries at Hamburgh, a mile south of Union Springs, and at Mosher's quarry east of the same place.

The quarry of Daniel Mosher is one mile east of the lake. It was first opened many years ago. But little stone was taken out until 1879, since which date it has been actively worked. The quarry is

nearly rectangular in shape and about 300 feet by 100 feet and 26 feet deep. The earth covering on the stone varies from one to six feet thick. The dip of the courses or strata is 5° southward. There are two sets of joints or seams ; one south 17° east, and a second set east and west. They are at convenient distances apart for working out the blocks of stone, and are generally open. The vertical succession of beds or *tiers* of stone, from the top down is as follows:*

1.	Blue limestone	12 inches.
2.	Blue limestone	16 inches.
3.	Blue limestone for flagging	3 inches.
4.	Blue limestone	14 inches.
5.	Blue limestone	22 inches.
6.	Blue limestone	4 inches.
7.	Blue limestone	4 inches.
8.	Blue limestone	7 inches.
9.	Blue limestone	8 inches.
10.	Blue limestone	9 inches.
11.	Blue limestone	11 inches.
12.	Blue limestone	20 inches.
13.	Blue limestone (flag-stone)	2 inches.
14.	Blue limestone	8 inches.
15.	Blue limestone	8 inches.
16.	Blue limestone	16 inches.
17.	*Clay*	6 inches.
18.	*Flint*	6 inches.
19.	Limestone	16 inches.
20.	Flag-stone	5 inches.
21.	Limestone	27 inches.
22.	Limestone	12 inches.
23.	Limestone	7 inches.
24.	Limestone	16 inches.
25.	Limestone	18 inches.
26.	Limestone	22 inches.

The bottom is shaly limestone, and under it there is a bed of limestone three feet thick. The strata, or as they are here termed, "*tiers*," are worked up into building stone, canal lock stone, and railroad bridge pier stone, flag-stone and platforms. The bedding faces at this quarry are somewhat rough, and hence the stone is better adapted for heavy work. The stone of the thick beds is gray, sub-crystalline, and

* From Mr. Shaper.

dresses well. The product of this quarry is now shipped for canal construction. There is very little water to be raised. Two derricks are used at the quarry and two at the dock on the lake shore. A large amount of stone from this quarry has been used on the Lehigh Valley R. R. at its Vosburg tunnel, Pa.

The *Hamburgh* group of quarries were first opened at least 60 years ago, and the old grist mill in the village was built of this stone; also the Chase House and the house of Robert Howland. And they are witnesses to its durability.

PHILLIP WINEGAR'S QUARRY is on the east side of the road, and is opened a length of 600 feet. Its working face is 40 to 50 feet deep. A vertical section shows: drift earth, with large limestone boulders, 10 feet thick; calcareous slate, brown color, two beds, five feet; blue limestone, in beds, one inch to 24 inches, 30 feet. At the bottom there is a bluish-black, slaty rock. The black, slaty-rock courses at the top answer for common rubble or wall work. The thick beds are used for heavy mason work, for which this stone is specially adapted. The courses, between three and four inches thick, are usually cut into flagging. The succession of beds corresponds with that at the Mosher quarry, and the flinty cap on the 24-inch-bed is 14 feet above the bottom of the quarry. The earthy layer, known locally, as "*soapstone*," also appears in this quarry, and over the "*flint*." Two derricks are in use in the quarry, and one on the dock. A tramway runs from it under the main road to the dock, one-fifth of a mile away. A large force of men is here employed in quarrying stone, and in *stripping* in the winter. At present the output is largely used for the construction of locks on the Erie canal. The stone are shipped by boat on the lake and canal.

THE QUARRY OF A. B. NILES is about 80 yards from the west end of Winegar's, and on the west side of the road. A large area has been worked over. These quarry beds show some disturbance, and as now exposed, the strata dip south, and are also horizontal in places. A track runs from the quarry to the dock on the lake. The place is at present idle.

PATRICK SMITH'S QUARRY is on the hill, 100 yards south of Winegar's, on the east side of the road. At the north end the beds dip 30° north-west, whereas in the centre and in the south part they are horizontal or nearly so. The quarry face is about 600 feet in

length from north to south, and runs in a zigzag course, owing to the rectangular joint walls. It has been worked back about 200 feet from the road, in an easterly direction. At the top there is drift earth and black slate, and the strata are found to increase in thickness as the hill rises, going eastward. The slaty rock can be used for common walls, but owing to a lack of demand, verv little of it is sold, and that at 25 cents per perch at the quarry. The succession of strata here seen, is the same as in the other Hamburgh quarries, as above described, and there is a remarkable uniformity and persistence in the strata, as opened in the several quarries in the vicinity of Union Springs. The thicker beds of the Smith quarry furnish strong and durable stone for solid masonry. At present the product is largely cut for construction of lock enlargement on the Erie canal, between Rochester and Syracuse. Stone from this quarry was used on the Vosburg tunnel of the Lehigh Valley railroad and in the viaduct of the New York Central railroad at Rochester. The quarry equipment includes six derricks. The stone is carted to the dock, an eighth of a mile away, on the lake, and is shipped by boat over the line of canal.

The quarry industry at Union Springs has not grown, owing to the many new localities which have been opened during the past twenty to thirty years. The canal work has to some extent revived the business. For solid masonry the stone is among the best.

AUBURN, CAYUGA COUNTY.—The Upper Helderberg limestone formation, which underlies Auburn and the adjacent country east and west, has yielded a large amount of stone for building in the city; and its percentage of stone buildings is relatively high. The main ledge on the eastern side of the city is continuous from the Osborne works, to and beyond the Goodrich quarry. The old Garrett quarry opened in 1810, is now covered in part, by the Osborne Reaper Works. The present quarry of the Garrett Stone and Coal Company, is east of the old quarry site, in the face of the same ledge. The strata dip gently to the south. The working is intermittent and for local use mainly. Former years saw more work, and the product went into buildings in the city, and to other points also.

THE QUARRY OF L. S. GOODRICH & SON is east of York street, and on the same ledge as that of the Garrett quarries. It follows the line of the ledge, and runs in a north-westerly and south-easterly direction for over 1,000 feet, and the face of the quarry fronts the

north-east. At the top, the rock is thin-bedded and shaly. The *stripping* is from six to eight feet thick. At the south end there is three feet of red earth on top of the limestone. The beds dip gently southward. The joints are regular, nearly vertical, and at right angles to one another. The main system runs a few degrees north of east. A vertical section of the beds here worked is as follows :*

1.	Blue limestone (for rubble work)	14 inches.
2.	Shaly limestone (worthless)	14 inches.
3.	Gray limestone (curb tier)	18 inches.
4.	*Flint*	1–3 inches.
5.	Gray limestone, for cut work	14 inches.
6.	Gray limestone	6 inches.
7.	Gray limestone (for large platforms)	12 inches.
8.	Gray limestone (heavy *tier*)	23 inches.
9.	Gray limestone (extra good)	12 inches.
10.	Gray limestone	24 inches.
11.	Light-blue limestone	5 feet.
12.	Blue limestone	3 feet.
13.	Blue limestone	4 feet.
14.	Blue limestone	1½ feet.
15.	Blue limestone	5 feet.
	Water-lime rock at bottom.	

The gray limestone of *tiers* Nos. 3, 5, 6, 7, 8 and 9, of the above section, is used mainly for dimension work, for curbing, gutter-stone, platforms and house trimmings. It is gray and of uniform shade and sub-crystalline in texture. The bottom bed of gray limestone is especially adapted for sills, lintels, water tables and house work generally. All the gray stone dresses *true* and when fine cut, has a light-gray color, making a pleasant contrast with the plain, rock face. The cartage is by teams to railroad, one mile away. The quarry plant includes four derricks and one steam drill. It is above the natural drainage, and no pumping is necessary. The output for 1887 was valued at $35,000, and about 60 men were employed. This quarry was opened in 1863.

JOHNSON & PARSELL work a quarry in the same ledge, but lower and at the valley level. It has a face 30 feet high. The stone is blue, hard and brittle, breaking with a conchoidal fracture; and the *tiers* are six inches to two feet thick. A small quantity is taken out annually for common wall work.

* Figures are from Mr. Goodrich.

BENNETT'S limestone quarry is west of the city. Only one to two men are employed and the product is unimportant.

The gray limestone of these Auburn quarries has been used largely and effectively in the five beautiful church buildings; in the city hall; in twenty-two store-houses; in the buildings of the Auburn Theological Seminary; the State Arsenal and the State prison. They witness to its beauty, both when fine dressed and as rock-face ashlar.

SENECA FALLS, SENECA COUNTY.—Small quarries, worked at intervals and for local use only, are opened in the limestone along the river at Seneca Falls.

WATERLOO, SENECA COUNTY.—Two quarries are opened and worked near Waterloo. They are in the Corniferous limestone formation.*

John Emmett's quarry is on the Seneca canal, one mile west of the town. A large space has been uncovered and quarried over. The covering on the stone is from four to ten feet thick; and the quarry courses or beds of blue limestone are, from the top down, as follows: 24 inches, 12 inches, 10 inches, 18 inches, 7 inches, 8 inches, 8 inches, 26 inches, 16 inches, 12 inches, 15 inches, 18 inches, 9 inches, 18 inches or 14 courses, which are quarried, and which have an aggregate thickness of 17 feet, nearly. The drainage of the quarry is into the Seneca river. The stone has been used in canal-lock construction and in churches in Geneva and Waterloo. The quarry was first opened in 1842.

Loren Thomas's quarry is half a mile south of the town, and the same distance from the N. Y. C. R. R. and the Erie canal. A large area has here been worked over, having a length of 1,000 feet or more from north to south. It has been worked for 60 years, having been opened first by the father of the present owner. The top earth is here from three to ten feet thick. The beds have a dip of 2° in a southerly direction. They are divided by joints, or seams, which run vertically, nearly west of north, at intervals of 30 feet or so apart, and the second a few degrees south of east at about the same distance apart. These joints assist very materially in the working of the quarry. A vertical section shows the following strata:

1. Blue limestone........................ 25 inches.
2. Blue limestone........................ 12 inches.

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* The formation is locally known as the Seneca blue limestone, and is in the upper part of the Corniferous or Upper Helderberg group.

3.	Blue limestone	16 inches.
4.	Blue limestone	20 inches.
5.	Blue limestone	7 inches.
6.	Blue limestone	9 inches.
7.	Blue limestone	7 inches.
8.	Blue limestons	22 inches.
9.	Clayey earth	7 inches.
10.	Chert on limestone	{ 6 inches. 17 inches.
11.	Limestone	14 inches.
12.	Limestone	11 inches.
13.	Limestone	16 inches.
14.	Limestone	17 inches.
15.	Limestone	18 inches.
16.	Limestone	9 inches.

The total thickness of the section is 18 feet 7 inches. At the south side of the quarry, at the top, there is more shaly stone, which answers for common, wall work only.

There are several derricks in use, worked by horse power. One steam pump raises the quarry water. The stone is carted to the railroad and the canal. The product is largely used for house work, canal and railroad bridge construction. The Waterloo stone can be seen in the basement of the Protestant Episcopal and in the Roman Catholic churches in Waterloo.

The Corniferous limestone formation has been opened in small quarries at Phelps Junction, in Gidding's quarry Canandaigua, and at Hog Hollow in the town of Victor, all in Ontario county. They do a local business.

LEROY, GENESEE COUNTY.—Two quarries are reported as opened at Leroy for building stone. They are in the Upper Helderberg or Corniferous limestone formation. The stone does for common, wall work, and fills the local demand, but it is not exported to any extent. Some of the limestone which crops out north of the town, is said to dress and polish well.

The same limestone formation has been opened in a small quarry at Caledonia, in Monroe county.

WILLIAMSVILLE, ERIE COUNTY.—Several quarries have been opened at Williamsville, ten miles north-east of Buffalo. J. S. & F. H. Youngs, and D. & H. Fogelsonger work quarries for building

stone, mainly for the Buffalo market. They are small and are not deep, as the rock is near the surface. The stone is light-gray, fine-crystalline and dresses well. It is used in Buffalo for cut stone trimmings. The quarries are six miles from the N. Y. C. R. R. line, but nearly all the stone is carted by teams to Buffalo. The geological formation is Corniferous.

BUFFALO.—In the city of Buffalo, a great part of the stone used in retaining walls, common walls, foundations and basements, as well as inside walls, has been obtained from quarries within the city limits. A group of these quarries is in the north-east part of the city, on the east side of Avenue A. The most northerly opening is that of the Buffalo Cement Company. At this quarry the Corniferous limestone is six feet thick, and rests upon an even-bedded, gray limestone, which may be eight feet thick, and underneath which, the cement rock is found. The limestone from this quarry is sold for building purposes in the city. The average price is $6.00 per cord. The main group of quarries is south of East Forest avenue, The first one at the north, and near the street, is that of Emilie Sutter; the next, south, is that of Joseph Armbruster, and adjoining it is that of John Gesl. These quarries really make one opening, the dividing line being simply that of property. Armbruster's quarry is nearly worked out, as this property has nearly all been quarried over. At the south side the face shows 18 to 20 feet of strata, extending from Avenue A to Gesl's line. A very plain system of joints runs east and west, vertically. There are two derricks, and the quarry is worked in a small way.

GESL'S QUARRY covers an area of two or three acres. The quarry beds are overlain by drift earth, varying from a few inches to four feet thick. They are even-bedded, horizontal, and from nine inches to two and a half feet thick; and the total thickness averages 20 feet. The stone is dark-colored, dense, hard, and contains much chert, particularly near the bottom. The top beds are generally thin, and the stone from them is used for common walls, selling at $6.00 per cord, delivered in the city. The heavy beds are cut into stone for locks, bridges, etc. There is very little water, and the drainage is natural. Two derricks are in use. A main system of joints run vertically east and west at spaces about 20 feet apart, on an average. The other seams or joints are vertical, but run in an irregular course.

JOHN ORTNER'S QUARRY is a quarter of a mile east of Gesl's. The quarry beds at this place, have a total thickness of 18 to 20 feet. One derrick is used, and a small force of men is employed.

The QUARRY OF CUTTER & BAILEY is south of that described above, and covers an area of at least 10 acres, having a working face of 1,000 feet in length from north-east to south-west. The strata are horizontal, with vertical joints or seams, 20 feet apart, and running east and west. There are ten beds, of which the thickest is two feet, and together, 18 to 20 feet thick. The *stripping* ranges from a thin soil to earth, three feet thick. The beds are above natural drainage. The plant consists of four, horse-power derricks. About 50 men are employed a large part of the year. The stone from these quarries is all sold in the city, and is carted by team from them to the spot where it is to be used.

ROCHESTER.—The Niagara limestone formation furnishes a large part of the common building stone used in this city. The quarries are located in the north-eastern and in the western parts of the city; and, generally, the stone is covered by a few feet of earth and boulder drift. One of the largest openings in the city is that of Foery & Kastner, on the east side of North Goodman street, and in the north-eastern part of the city. At this place about two acres have been gone over to a depth of 25 to 30 feet. On the top there is an uneven bed of gray limestone. It is underlain by 15 to 18 feet of even-bedded stone, of a darker shade in color, resembling some of the Trenton limestone. The gray limestone dresses more readily than the latter, and is the best of the quarry. This stone is used for cellar walls, foundations, basement and party walls, and to a slight extent, as rock faced ashlar, for building purposes. Steam pumps for raising the water and steam drills are used. The average price is $1.00 per load at the quarry, and it is sold in the rough to builders, who put it in rubble work or square it for course work.

LOCKPORT, NIAGARA COUNTY.—The Lockport gray limestone is quarried in the city by Chas. Whitmore and by B. & J. Carpenter. The quarries are in the south-west part of the town, along the canal, above the locks and south of the N. Y., L. E. & W. R. R. Whitmore's quarry is worked in a small way, at intervals. The Carpenter quarry has an opening on both sides of the canal, but the main working is now on the north side. The beds are above the canal level, and the quarrying work has extended over a distance of 200 yards from

north-east to south-west, and back nearly to the railroad line, making an area of several acres from which stone is extracted. The locality was first opened when the canal was dug, in 1825; and the Carpenters began work here in 1829. The stone is covered by soil, and the top beds are thin, for three feet or so in depth; then comes the gray limestone, having a thickness of 12 to 24 feet. At the bottom there is hydraulic limestone, six feet thick, and under it a black, shaly rock. The quarry stone has a grayish shade of color and crystalline texture. The beds dip south at a low angle. There are no seams or regular sets of joints in the rock. It dresses well; is solid, dense and specially adapted for heavy masonry, as well as for house trimmings and cut work. When fine cut the surface is not very different in shade from the rock. Formerly a large amount of stone was quarried here for building purposes, but since the great increase in the use of sandstone this limestone has been comparatively neglected. It has been used for monumental work also. At the present time the stone is being quarried for canal lock construction. There are three derricks in the quarry, besides a double, traveling shed derrick.

The Lockport gray limestone has been employed to a large extent in stone construction at home, and the curbing, crosswalks, canal locks, N. Y. C. R. R. viaduct, several store-houses and church buildings, shows how well it stands the exposure of years, and its durability. As a cut stone for trimming, with brick walls, it has been used extensively. Outside of Lockport it has found markets in Buffalo, Niagara Falls and other cities. A fine example of the stone, fine dressed, is in the Lenox Library building, on Fifth avenue and Seventieth street, New York city.

NIAGARA FALLS.—The Niagara limestone formation, affords stone for building in the Falls village, and small quarries are opened in the vicinity of the place. They do not sell stone to other points.

SLATE.

Shushan, Washington County.—A slate quarry was opened here about four years ago, on lands of Daniel Dobbins, near the Batten Kill, and one mile south-west of Shushan. There are two openings about 50 yards apart, in a northerly and southerly line, and about 150 yards south-west of Dobbins house. This quarry was reopened in 1887 by a New York city firm, and was worked about six weeks. The main opening is 75 yards long, and about 30 yards wide and 40 feet deep. The bed dips at an angle of 40° eastward. There is very little earth on the rock, and originally, the slate cropped out. The rock on the west and south sides of the opening is purple, green and variegated in color. Two derricks, worked by horse power and a shanty, with a trimming machine, make up the quarry plant. The work had been suspended at the time of visit, and the bottom of the quarry could not be seen. A small stock of roofing slate was on the bank.

Salem, Washington County.—South-east of Salem a half a mile, three quarries have been opened for roofing slate. Two of these quarries are worked by C. H. Pierce, and the third by John N. Williams & Co. The Pierce quarries were opened three years ago, and the excavations are about 40 feet deep. The southern opening is about 40 x 60 feet in size. The drift earth which covers the slate averages seven feet in thickness. The beds dip at an angle of 20° east-south-east. The north-east opening is small and is now idle. These quarries produce roofing slate and flag-stone. The stone, unsuited for roofing or for flagging, is used in the town for walls and foundations.

The Hawley Farm quarry, about 300 yards south-west of the Pierce quarry, is leased and worked by John N. Williams & Co., and was opened the last season (1887). It has reached a depth of 45 feet on the dip, but is only about 30 feet square. The strata dip 40° east; the cleavage is in the same direction. The slate has a greenish color, and is known as unfading green. The water is raised by a barrel, and a one-horse derrick answers for hoisting the slate. This quarry has not been opened sufficiently to develop a large body of good slate, but it is promising.

KAYS' QUARRY also is in the town of Salem, and on the Christopher Morey farm, in the Black creek valley, and four miles north-west of Salem. It was opened in April, 1886, by Hugh Kays, of Salem. The opening is 60 x 40 feet, and 45 feet deep. The slate is red and is said to be quite as deep-colored as that of Granville.

In what may be the same range (or "vein" of the slate quarrymen), there is the Douglass quarry, which is located about three and a half miles south-south-west of Granville and near Slateville, in the town of Hebron. It produces a red slate. During the past season it was idle.

GRANVILLE.—The Granville red-slate *vein* or range is traceable for two miles northward from Granville, east of Middle Granville, and nearly parallel to the Vermont line. It is narrow, in places not over 30 rods wide, and its surface very rocky. The strata crop out in numerous low, glaciated knobs and ledges. Quarries and trial pits have been opened at many points. The following quarries are noted here, beginning at Granville:

The quarry of Evan J. Roberts and John Hughes is in the northern part of the village of Granville, and about 100 feet west of the Middle Granville road and the D. & H. R. R. line. The opening is 150 x 45 feet, and 20 to 30 feet deep. The beds dip 50° south 82° east. One system of joints runs north 85° west and is vertical; a second, has its joint faces dipping 40° west. The covering of earth on the slate rock at this opening, was not more than two feet thick at any point, and the rock, as seen in the outcropping ledges near the quarry is solid and hard. Some white calcite and milk-white quartz are seen in the joint surfaces. The cleavage coincides with the dip of the beds. The varieties of slate here obtained are green and red. The red slate is fine-grained, homogeneous and bright-red in color. There is one derrick on the dump, at the south end. The quarry has not been in operation during the past season.

Going north on the line of the red-slate "vein" the next opening is about 120 rods to the north, and 40 rods east of the railway. It is small and at present, partly filled with water.

The quarry of John J. Williams is north of the last mentioned locality, and on a ridge about 50 feet above the Granville terrace, and perhaps 80 rods from the railroad. The opening is 100 feet long and nearly as wide. The depth averages 50 feet. The beds dip 40° east-south-east. One well-marked joint system runs east and west. The second is less plainly marked, at right angles to the first; and

both are vertical. The cleavage planes have the same direction as the bedding. The greater part of the slate obtained in this quarry is red. The quarry is unwatered by means of a siphon; and the slate blocks are raised by one derrick, worked by horse power.

North of the Williams quarry and on the same ridge two quarries have been opened and worked, but work in them has been discontinued.

The quarry of Wallace & Hitchcock, north of these abandoned quarries, is also idle. At all of these openings the slate rock shows the same general direction in dip, and at an average angle of 38° to 40°.

The quarry of Hugh Williams, on the Hammond farm, is about a quarter of a mile north of the last mentioned locality. It is about 80 by 40 feet. The dip of the strata is eastward or east-south-east. This locality also has been idle for three years.

Going north, the quarry of William F. Williams & Sons, is on lands of W. Crosby. The opening is in a low depression or wet swale, at the eastern foot of a low lying ledge of red-slate rock. The slate here was found covered by a thin bed of white, clayey earth. The quarry dimensions are 100 feet by 50 feet, approximately; and 55 feet deep. The dip of the strata and of the cleavage plane is 45° easterly. One main seam or joint system is vertical, and runs east and west. Both green and red slate are found in these quarries. The green variety is seen crossing the strata obliquely. A steam pump, running for five hours a week, raises the quarry water. The slate blocks are raised by a horse-power derrick. This quarry was opened four years ago.

The quarry of Wm. A. Nixon also is on lands of W. Crosby, and a few rods only, north of the Williams quarry. There are two openings, and they are close to the road, on the south side of it. At the southern one, which was begun in the season of 1887 a depth of 25 feet has been reached. The strata dip south 75° east, and at an angle of 45°. A red slate is obtained here, but the place is not yet opened fairly to indicate its value. The old quarry of Nixon, which is now idle, is several rods north of the above and near the road. A large amount of roofing slate has been taken from it and the heaps of waste rock about it are large. Nixon's quarry is east of, and in beds a little higher than those of Williams', and, apparently, higher than those which are opened on the north and across the road. It is a half a mile south-east of Middle Granville.

A few rods north of the main road, and on the Crosby property a slate quarry has been opened and worked by a Boston company. It is located on the eastern side of a low and rocky ledge, and the covering of white, drift clay on the slate was much like what was seen at Nixon's and at Williams' quarries. This opening is about 50 feet square, and 25 to 30 feet in depth. Both green and red slate occur in this quarry. The beds and cleavage planes dip at an angle of 40° easterly.

About 50 yards north of the Boston company's quarry there is an old opening, which is now partly full of water; and north of the latter are the abandoned workings of the Eagle quarry. All of these quarries produced a red slate. In the same range, and a few rods north of the old Eagle quarry, slate is raised by Robert B. Pritchard. He has two openings, of which the southern one only, is worked. It is about 50 feet square, and 30 feet deep. The covering and the location are very similar to the neighboring quarries to the south. The beds dip about 40° a little south of east. The main system of joints runs in the line of dip, and they are vertical. The slate has a deep red color. One derrick, worked by horse power, serves to raise both the stone and the water, of which there is at times a great deal, as the location is swampy. These quarries are within a half a mile of the railroad station at Middle Granville, where the slate are loaded and shipped to market.

MIDDLE GRANVILLE.—In the village of Middle Granville a slate quarry is opened and worked south of the main road, and on the west side of the Pawlet river. It is located on flat ground but a little above the stream, and the covering of drift earth is only a few feet thick. This opening approximates about 250 by 80 feet in size, and has a depth of 50 feet. The bed dips 30° east-north-east. The main joint system runs in the same direction and dips very steeply southward. At the north end of the quarry there is a slip, or joint, whose planes dip at an angle of about 60° east. The purple, green, and variegated varieties are here obtained; and the greater part of the output is split into roofing slate. One derrick, worked by horse power answers for raising the water and slate.

PENRHYN STATE COMPANY'S QUARRIES.—These quarries are from a quarter to three-quarters of a mile north of Middle Granville, in the eastern side of a steep ridge of slate rock. The slate has been opened at several points on the lands of the company, and on the adjoining

farm of John Fyfe. The three southern openings or quarries, are quite close together, and west of the mill. The first one is approximately 300 x 200 feet, and nearly 100 feet deep, and the second, 200 x 100 feet, both being 10 to 20 feet deeper at the upper or west side. At present they are partly full of water, and the only work is in the top rock at the side of the southern-most pit. The main quarrying of the company is now on the Fyfe property, and in what are here known as Nos. 1, 2 and 3. They also are large pits, and from 70 to 100 feet deep. The dip of the strata in all of these quarries is east, and at an angle, on average, of 40° to 50°. Green, purple and variegated slates are obtained, and, generally, these different colored rocks occur in separate beds. The variegated consists of green and purple mixed. The joints or seams traversing the rock, are not well defined in these quarries. Generally, one system runs in the same direction as the dip of the beds, that is easterly, and vertical. A very large amount of material has been taken from the openings in this hill, and the hugh dumps indicate the extent of the work, as well as show how much waste is incidental, necessarily in opening and developing slate quarries. There is not much machinery employed, other than horse-power derricks and pumps run by steam power from the mill. At all of these quarries in the side hill adits and short tunnels admit of unwatering, down nearly half the depth, and save some hoisting. The splitting and trimming of the roofing slate are down in shanties or booths, on the dumps at the quarry. . The blocks for cutting are hauled by teams to the company's mill, which is within a half a mile of the furthest quarry. The work of getting out slate at the quarries is done on the contract system, the men furnishing the blocks of slate at certain rates, according to the stock which is cut from them. The company works up the product of the quarries in its mills, except a comparatively small part which is split up into roofing slate. The greater part is worked up into plain, marbleized, decorative and enamelled material, as mantles, steps, house trimmings, table tops, laundry tubs, wainscoting, floor tiles, etc. The purple and green slates are generally used for marbleizing, as they are more abundant, softer and cheaper than the red, which finds a market for ornamental work. The purple slate of these quarries is deeper and richer in color than the Vermont purple slate. The latter has more of a brown shade. The Middle Granville quarries were first opened about 1850.

The Penrhyn Company's mill is east of the quarries and at the side of the Pawlet river. It is equipped with machinery for cutting,

rubbing and marbleizing slate, and it works up a large amount of slate rock from other quarries, both in this county and in Vermont. It is the only establishment of the kind in the State. Their other mill is at Hydeville, Vermont. The product of the mills is 14,000 square feet per month.

The METTOWEE RED SLATE COMPANY operates a quarry of unfading green slate on lands of the Empire Slate Company, three miles north of Middle Granville, and on the west of the Rutland & Washington railroad. It is in the town of Granville. The quarry is considered as one of the best of the green-slate range in this section. The slate is a gray-green in color.

Red slate has been worked on the east side of the Pawlet river, north of Middle Granville. The quarries are as yet small and not productive. They are west of the Granville range.

On the TERENCE CROTTY farm, one and three-quarters of a mile north of Middle Granville and east of the E. Whitehall road, there are three openings in red slate. They have not been worked in four years.

The ALLEN SLATE QUARRY is about 50 rods north of Crotty's, on the west side of the road and near the Allen farm-house. It was first opened in April, 1883, and worked up to two years ago by the Mettowee Red Slate Co., Hugh Williams, manager. The excavation is approximately 150 x 30 feet, and 60 feet deep. The average dip is 70° east. The earth on the rock is thin, and the top rock, where it has been uncovered, appears to be solid and unaltered. The slate is bright red in color. When worked the percentage of waste was said to be unusually small.

The Mettowee Red Slate Company furnished red slate for the Union League building and the Vanderbilt house in New York city, and for the Mark Hopkins house, at Great Barrington, Mass.

METTOWEE OR NORTH BEND RED SLATE.—North of the Pawlet river, and about one and a half miles north of the steel bridge two quarries have been opened lately. They are in the town of Granville. What is known as the Pinkham quarry is about 100 yards west of the East Whitehall road. The quarry has reached a depth of about 50 feet, and its estimated length is 80 feet. The beds dip 42° eastward. The covering of earth is from 1 to 3 feet thick, but about

15 feet of the top rock is not workable, and is included in the *stripping*. There is a little green slate on the east side, at the top but the mass of the quarry is bright-red in color. The main system of joints run east and west and vertical. A second system runs obliquely to the first, south-south-west, and dips steeply to the west-north-west. The company working these quarries is known as the Annifian Slate Trust, of Boston, of which Geo. F. Pinkham is the principal owner. It was first opened about three years ago. The present company reopened it in July, 1887. The plant consists of one derrick and one pump, both run by steam power.

Half a mile north of the above is the quarry of Hugh Williams, of Middle Granville, and on lands of Edward S. DeKalb. The opening is about 80 feet by 50 feet, and at least 30 feet deep. The *stripping* is drift earth, and about three feet thick. The lower beds dip uniformly at an angle of 40° north 85° east, and the cleavage planes have the same direction. The main system of vertical joints runs north 80° east; the other sets of joints are quite irregular. The beds have been worked down 60 feet on the foot-wall of the quarry. The color is bright red. The best material is split into roofing slate. The more solid stone of the waste or refuse is used for building stone. One derrick serves for hoisting the stone and water. The quarry was first opened in 1884; it was reopened April, 1887.

The slate from these quarries is carted to the railroad at Middle Granville, three and a half miles distant. At Raceville the railroad is within one and a half miles of the quarry.

EAST WHITEHALL, WASHINGTON COUNTY.—This range, or *vein*, of red slate, is in the town of Whitehall, nearly six miles from Middle Granville, and the same distance south-east of Whitehall. The locality is known as Hatch Hill. There are four quarries, opened within a length of a half a mile, from north to south, on the line of strike of the rock. The surface is wet and swampy, and on the west there is a ridge about 100 feet high above the quarries.

W. A. Nixon has the most southern opening on the hill. It is not yet developed into a producing quarry, although good, workable slate rock has been uncovered.

R. A. Hall's quarry is at the edge of the swamp on the south and close to the hill, on the west side. It is about 200 by 100 feet and 100 feet deep on the western foot-wall. On the east side the slate is covered by swamp earth and clayey drift; on the west the rock crops out in the surface. The beds dip easterly at an angle of 40°.

Red slate is quarried here, and the greater part of it is worked up into roofing material and tiles for flooring. The mill for sawing the tile is at the east side of the quarry. Steam pumps, steam drills and steam derricks are here in use. From eighteen to twenty men are employed during the working season. The manufactured slate and tile are carted to Whitehall, six miles north-west of the works, and there shipped to markets.

The Hall mill for tiles is located at North Granville. A novel use of the waste from this quarry is grinding it for paint. It is used as a filler in making oil-cloth also. The Hall quarry is represented in the Gilsey House, New York city.

The Ainsworth quarry is about 40 rods north of that of Hall, and is in the low ground. Its dimensions are, approximately 150 feet on the line of strike by 80 feet in width, and 80 feet deep, at the east side. The beds here opened are a little west of the range of the Hall quarry, and lower. There is a remarkable fold in the strata, thus exposed in the vertical sections of the north and south walls of the quarry; and the arch or crown is seen at the west and the axis further east, dipping eastward at about the same angle as the dip of the strata above and below it — 40° south 82° east. The rock in this fold and middle section of the quarry is hard and does not work well, and it is thrown out as waste. The best material is found in the bottom beds, under the fold. The main system of seams, or joints, runs an east-west course, vertically; a second set, with calcite-coated surfaces, trends in an east-north-east direction, and vertically. The quarry water comes largely from the swampy surface. It is raised by a steam pump. The hoisting of the slate blocks is by a horse-power derrick. The slate is of bright-red color, and homogeneous in texture. A part is worked into roofing at the quarry, and a part is carted to Middle Granville, and thence is shipped to the mill at Castleton, Vermont, where it is cut into tiles, sills, lintels, billiard table tops, etc. This quarry is on the Holcombe farm. Hiram Ainsworth, of Castleton, Vt., is the lessee. It was opened first fourteen years ago. The working season lasts from nine to ten months each year.

Herbert's quarry consists of two small openings about 200 yards north of the Ainsworth quarry. The southern one only is worked. The dip of the strata here is 45° (approximate) and eastward. The slate is bright-red, and it is well exposed in the outcropping ledges near the quarry on the west side. The surface rock has somewhat of red

shale interstratified with the slate. The work of pumping and hoisting is done by steam power. Roofing and tile slate are produced. The red-slate outcrop is traceable north from the quarry, up the hill to the road and thence onward.

The East Whitehall slate is noted for its bright, cherry-red color, its fine, homogeneous texture, and its freedom from pyrite. As compared with that of the Granville range or *vein*, it is brighter in color, it is worked more easily, and it is considered by slate men to be superior for roofing material.* The *vein* is more persistent and uniform in character than the latter. The output of these Hatch Hill quarries varies from year to year. In 1887, they produced about 1,500 squares of roofing slate besides the sawed stock. It sells for $10 per square, delivered on cars or boat; and there is a steady demand for it.

* It should be stated here that the East Whitehall quarries are nearly twice as deep as the quarries in the Granville red slate range or *vein*, and generally in all districts the quality improves as the quarries get deeper in the rock.

APPENDIX.

Statistics of Quarries.

According to the statistical tables of quarries and their production, in Volume X, pp. 46–49, tenth census of the United States, 1880, New York had 55 marble and limestone; 181 sandstone; 3 crystalline siliceous rock; and 12 slate quarries, which did a business, each of over $1,000, during the year that the census was taken. There were 3,302 laborers employed in these quarries and the value of the product was $1,261,495.

The survey for this report shows that in 1887 the number of working quarries was 342; and distributed as follows:

1.	Granite and gneiss	11 quarries.
2.	Marble	7 quarries.
3.	Sandstone	235* quarries.
4.	Limestone	73 quarries.
5.	Slate	16 quarries.
		342

The total number of laborers employed, including quarrymen and stone-cutters at quarries, was 5,400,† an increase of one-third over the number reported by the United States census.

The value of the equipment or plant is estimated to be not less than $1,600,000. It represents the machinery, tools and sheds necessary for quarry work, and excludes mills for cutting and dressing the stone.

The value of the product (estimated at)	$3,500,000‡
The value in 1880 (United States census)	$1,261,495

*Including 144 quarries in the Hudson River blue-stone belt of territory, as reported in the United States census for 1880.

† The number of men employed in the quarries and in the quarry districts is from individual statements of owners or managers in great part; a few localities are estimated; and the Hudson River blue-stone district estimate, of 2,000 men, is from Wm. B. Fitch, of Kingston, Ulster county.

‡ The total value is made up of statements for the several, larger quarry districts, obtained from managers well acquainted with the extent of this industry, supplemented by estimates made in the office, and based on the comparative number of men employed.

HUDSON RIVER BLUE-STONE.

The following statistics of blue-stone for the year 1887 are furnished by the Union Blue-stone Co., 280 Broadway, New York.* They show the amounts of the different grades which were quarried and the several uses to which they were put.

OUTPUT OF BLUE-STONE BY UNION BLUE STONE COMPANY, 280 BROADWAY, NEW YORK, FOR YEAR 1887.

DESCRIPTION.	Feet.	Pieces.
Flagging	3,188,217	
Platforms	29,019	
Rock	23,878	
Cut garden	25,793	
Curb	877,424	
Gutter	126,539	
Sills	426,671	
Coping	343,020	
Door sills	3,639	
Steps	12,234	
Belgian bridge crossings	150,920	
Rubbed sills	125,791	
Rubbed curb and lintels	67,276	
Axed, twenty-inch curb	40,129	
Rubbed flagging and hearths	55,815	
Planed flagging	100,311	
Planed headers	57,252	
Planed platforms	31,897	
Sawed and planed	58,734	
Well stone	8,496	
Elevated railroad foundation stone	....	3,467
Corners	....	1,340
	5,753,055	4,807

In addition to above there was $93,000 of manufactured stone sold for building and other purposes.

As these figures represent nine-tenths of all the blue-stone, which is quarried in the State, the total output may be safely stated to be 6,400,000 feet, and its value, in round numbers, $1,750,000.

SLATE.

The output of red-slate, in roofing, for 1887, is reported by W. A. Nixon of Middle Granville, to amount to 5,000 squares.

* Union Blue-Stone Company, Sam'l Coykendall Pres't, and Sam'l Coles, Treasurer.

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BULLETIN

OF THE

NEW YORK STATE MUSEUM

OF

NATURAL HISTORY.

No. 4.

AUGUST, 1888.

SOME NEW YORK MINERALS AND THEIR LOCALITIES,

Prepared for the New York State Museum of Natural History,

BY

FRANK L. NASON.

PRINTED FOR THE MUSEUM.

ALBANY:
CHARLES VAN BENTHUYSEN & SONS,
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INTRODUCTION.

This bulletin has been prepared at my request by Mr. Frank L. Nason, of the Geological Survey of New Jersey, formerly of the Rensselaer Polytechnic Institute of Troy.

Mr. Nason was employed for a time by the State Museum to assist in the work of arranging for exhibition the general collection of minerals; and, also, in collecting minerals in Essex and Warren counties.

Three suites of minerals in the general mineralogical collection of the Museum are noticed in this bulletin. And it is divided into the following parts, descriptive of these three several collections:

1. A description of a new locality of fine brown tourmaline and associated minerals, brought to the notice of the Museum by Mr. C. E. Beecher, consulting palæontologist of the New York State Museum and assistant in the Yale University Museum.

2. A notice of some pyroxenes and associated minerals, found at the Chilson Hill mine, in the town of Ticonderoga, Essex county, by C. E. Beecher and Frank L. Nason.

3. Calcites collected by the late Prof. E. Emmons, State Geologist, at the lead mines of Rossie, St. Lawrence county, N. Y.

The first and second collections, here mentioned, represent the direct work of the Museum within the past two years; the last represents, also, although indirectly, work done about fifty years ago.

No attempt has been made to give a strictly technical description of the minerals noticed, but it is hoped that this bulletin may serve to direct the attention of students to them and to some special features of the Museum collections.

JOHN C. SMOCK,

Assistant-in-charge N. Y. State Museum.

ALBANY, N. Y., *August*, 1888.

SOME NEW YORK MINERALS AND THEIR LOCALITIES.

I.—NEWCOMB TOURMALINES.

There are many specimens in the collection which, for various reasons, demand more than casual mention. Among these may be noted, material from a newly discovered locality at Newcomb, Essex county, N. Y. This locality has yielded some of the finest specimens of brown tourmaline yet found. The exact position of the bed is on the south shore of Lake Harris about one mile east of the post-office in Newcomb. These tourmalines occur in the Laurentian limestones which are so abundant in the valleys of the Adirondacks. The same limestones occurring in the northern part of New Jersey, in Orange county and in northern New York, all bear more or less brown tourmaline. The most famous locality, however, is Gouverneur, N. Y. For the most part, the tourmalines occurring in other places are very fragmentary, presenting the appearance of having been nearly dissolved after being formed. It is not of infrequent occurrence that crystals are found having only one or two of the R-faces present with traces of the prism, or that a fine termination is present with a diameter of one to three cm. with the c. axis no more than five mm. in length. In other cases mere crystalline shells appear, or fine veins may be completely filled with the formless mass. In general the mineral is only feebly transparent and more usually opaque. Even when in large, finely developed crystals the contrary is a rare exception. In many cases, however, the opacity of the crystal is due to numerous fine shivers passing in every direction, and there is a decided cloudiness which renders the crystalline masses opaque. Many of the larger crystals have a single termination at one extremity, while the other will have from two to twelve distinct terminations, and should the inclosing calcite be dissolved away for a short distance, they would give the impression of as many distinct crystals having

a parallel growth. Color is also a varying characteristic of these tourmalines. In northern New Jersey, for instance, the crystals have a faded, appearance, evidently not arising from incipient decomposition, since, on all sides they present a highly vitreous lustre, and the polish of the surfaces is hardly broken. So far as instances have come under my personal observation this rule admits of hardly an exception. In the New York limestones, however, even when the color is not deep there is a vividness about them which makes a decided contrast to the New Jersey crystals. I mentioned the fact that these crystals often had the appearance of being nearly or quite dissolved. In addition it will be well to state that this condition is owing to other causes than solution. Within most of the crystals of larger size, rounded masses of calcite, as coarsely crystallized as the surrounding rock, are enclosed and also globules of quartz.

The tourmaline is distributed irregularly through the entire mass of the limestone in the localities named. Graphite, apatite, sphene and wernerite are associated with it. Quartz, crystallized, is found very rarely, but it is quite abundant, either as irregular shaped, pitted nodules or as flattened and warped plates with the same pitted appearance. The graphite occurs in thin laminæ, often in decidedly hexagonal tablets. Though generally lying between the crystals of calcite and parallel to their faces it often cuts through them irregularly and is found enclosed in the body of nearly all of its associates.

The limestone itself is very coarsely crystalline, some of the cleavage surfaces measuring a cm., more or less. The color varies from a dull grayish-white, to white, blue and red. Cleavage pieces vary from dull opaque-milky to almost transparent.

The foregoing, are briefly, the general characteristics of the Laurentian limestones in localities which I have visited. In the immediate vicinity of Newcomb these characteristics remain the same. Everywhere are evidences of intense metamorphism.

One very limited area, however, presents an entirely different appearance. The area covered by the "brown tourmaline locality," is about ten feet wide by fifteen broad, and from three to five feet in depth. In this pocket the limestone has been changed to an almost transparent, yellowish-white and coarsely crystallized calcite. Embedded in this gangue the following minerals were found in good crystals, some very fine: Tourmaline, brown and green, blue apatite, sphene,

zircon, muscovite, smoky quartz, scapolite, albite, graphite, tremolite, pyroxene and pyrite.

The difference between the enclosed minerals is even greater than between the limestones within and without this area. The tourmalines are occasionally of very large size; one crystal measures eight inches in length by four inches in breadth, or twelve inches in circumference. Excepting on the surface, and thus exposed to weathering, the crystals are all remarkably fresh in appearance. They are of a rich brown or green color (rarely greenish-black and subtranslucent, from depth of color), and perfectly transparent. A large number were found entirely free from flaws and furnished beautiful gems, though of small size. The greater number of the stones thus cut were fragments of crystals. A number of crystals were found, however, of the length of five to ten mm., doubly terminated and without a flaw. Larger crystals, from one to two cm. in diameter, are very clear and are translucent notwithstanding their many flaws. Fragments, which would cut a fine stone, may often be broken from these crystals.

These tourmalines show no new or even rare faces. The zero plane is of infrequent occurrence. The general habit of the crystals is short and stout. They often exhibit a parallel growth of a large number of crystals, having a common termination with adventitious crystals of shorter length along their sides. The phenomenon before mentioned, of one crystal having a single termination at one end and several at the other, is here of frequent occurrence. These crystals also enclose large rounded globules of calcite, and occasionally of quartz. Graphite and scapolite are of more rare occurrence. It not infrequently happens that large, beautiful and apparently perfect crystals turn out to be no more than thin shells or series of shells, enclosing masses of calcite. Sometimes one termination will be perfect, with the body of the prism a mass of cells; or the prism faces will be apparently perfect, while the terminations are entirely wanting. Thin plates with the polished surfaces of the R-faces are very common. Finally, fragments of quartz and scapolite are often found with innumerable fine veins filled with tourmaline.

Another mineral of common occurrence in this locality is sphene or titanite. It is found in very small, tabular-shaped crystals, and more rarely in crystals of eight cm. or more in length, and with corresponding dimensions. In color the crystals range from nearly black to chocolate, brown, red and clear honey-yellow; varying from opaque to semi-transparent.

In many of the larger crystals there is a very distinct cleavage, more nearly perfect than usual and, seemingly, to be referred to the same cause which, according to Dr. G. H. Williams (Am. Jour. Sci., Vol. XXIX, p. 486), produces the apparently perfect cleavage in many American sphenes. Twinning in the smaller crystals with the re-entrant angles, "arrow twins," is the most common.

Large crystals quite frequently are found evidently altering to rutile. At least one large crystal was found having long needles of rutile, fifteen mm. in length by one to two in diameter. The mineral gives a strong fetid odor when struck; before the blow-pipe it changes from a dull gray to a translucent honey-yellow, fusing at about four to a grayish-black glass; in the closed glass tube it gives off considerable water. Calcite is intimately mingled with the crystal, but whether from inclusion or the result of decomposition, I cannot say. There are yellow crystalline (zanthitone ?) substances enclosed, which give distinct titanium reactions. The enclosed rutile crystals, splendent, show a distinct crystalline form, and are distributed irregularly throughout the mass of the crystal. The fetid odor is probably due to the presence of sulphur, since it looses this odor when heated.

Perfect crystals of tremolite are also found, rather dark in color, but yet translucent. Beautiful, translucent crystals of blue apatite are very abundant, but are too small to be of much value as cabinet specimens. They occur in the calcite, though often penetrating crystals of wernerite.

The zircons found in this locality are deep greenish-black, and are opaque except on the edges. The crystals are of the simple prism combined with one set of pyramidal planes. They are not numerous.

Pyrite is found in large octahedral crystals, and always much decomposed. In many cases decomposition is complete.

In form the smoky quartzes are somewhat unusual, though not at all rare. The pyramidal faces are, in the majority of cases, wanting, the crystal terminating in a long taper, the result of successive attempts at termination. Though the crystals are usually very clear and transparent, it is not noticed at first on account of the roughened, apparently corroded faces. Crystals are found, however, with polished faces, having the appearance of quartz partially dissolved, and having a "washed-out" or faded color. Quartz of a milky-white color is found, but such crystals are not common. They follow the general form of the smoky quartzes.

Muscovite occurs of a clear, yellowish-green color in the direction of the a. axis, but reddish-brown in the direction of c., and viewed through a., it is transparent; through c., feebly translucent in thick crystals. The largest crystals are no more than two cm. by one or one and a half. The general hexagonal form of the crystal is easily distinguished, though perfect faces are rare.

The albite occurs in druses generally, though some crystals are from one to three mm. long, and these druses are glassy and perfectly transparent. The mineral occurs coating the surfaces of all the other minerals, and sometimes filling seams of broken crystals. Fragments of large, translucent crystals are found measuring more than five cm. in diameter. These fragments often have a beautiful, pearly lustre and a soft opalescence. Very handsome stones have been cut from some of these fragments.

Graphite occurs much in the same form as in the surrounding limestones, though apparently not quite as abundant.

Dipyre crystals occur from minute drusy, to large crystals, five to ten cm. in length. All are glassy, translucent to transparent, and in color, vary from a grayish-green to apple green. Large crystalline masses occur, enclosing crystals of sphene, penetrating quartz and tourmaline, and the surface of the masses, as it reaches into the enclosing calcite, is covered with glassy, drusy crystals, though some are of considerable size. The dipyre crystals also have the pitted appearance, as though incipient fusion had taken place, or solution had begun to remove part of the mass. The large crystals enclose in globular cavities masses of perfectly crystallized calcite.

Many crystals have long, dark, acicular enclosures, which are arranged parallel to the vertical axis with great regularity. These acicular crystals vary from one to fifteen mm. or more in length. Some are barely visible to the naked eye, while others, show a splendent metallic lustre when properly turned. Some crystals are apparently free from these enclosures, but the microscope reveals them in great numbers. In general, under the objective they are too minute to give any intimation as to their form. They are usually nearly or quite opaque. What little light is transmitted appears of a reddish brown.

Rosenbusch, in his "Mikroskopische Physiographie," second edition, page 318, describes minerals of the scapolite group occurring under similar conditions and containing similar inclusions, but in the granular limestones, the crystals are quite regular and free from

inclusions. With the exception of muscovite and quartz inclusions and the fact that the mineral occurs in granular limestones, Rosenbusch's description is quite applicable to this mineral. Since there is no way of distinguishing wernerite from dipyre, save by chemical analysis, a quantitative silica determination was made. The average percentage of silica was 57.20. Since the percentage in wernerite ranges from 44 to 48 per cent, and in dipyre from 55 to 60 per cent; and, since both Hussak and Rosenbusch agree that rutile is a rare inclusion in wernerite, I think the mineral may safely be called dipyre.

II.—CALCITES FROM ROSSIE, ST. LAWRENCE COUNTY.*

The calcites from Rossie, N. Y., collected by Prof. E. Emmons, deserve special mention. They were taken from the Coal Hill and adjoining lead mines in the town of Rossie, St. Lawrence county. The mine was opened about 1836, but was operated at a loss, and was abandoned a few years later. During the process of working, however, some of the finest calcites in the world were obtained. Of these, the Museum has, probably, the finest and most extensive collection extant. All the different forms figured by Prof. Beck in his "Mineralogy of New York," and by Prof. J. D. Dana in his "System of Mineralogy," with a few exceptions, are represented.

There are no unmodified rhombohedra, and it is quite probable that none were found. Scalenohedra of the simple type are not common. Every crystal, without exception, is twinned, some of the twins being very complex. The descriptions given by Prof. Beck, will be found on page 224, "Mineralogy of New York." The twins found at Rossie are usually parallel to the O-face. Sometimes the O-plane is present on one of the crystals and not on the other, sometimes on both, and then on neither.[1] It frequently happens that when two crystals are thus twinned only three of the R-planes of each crystal are present, while the O-planes are developed to such an extent that the crystals appear in the form of a thick, triangular crystal with bevelled edges, or rather, in the form of a truncated triangular pyramid.[2]

In another form two crystals are twinned parallel to i. and to a third crystal parallel to the O-face.[3] On two crystals the O-face is developed, on the third it is lacking. Not rarely crystals are found with from

* Collection made by the late Prof. E. Emmons, of Williams College, about 1838, at the Rossie lead mines.

[1] For references see plate at the end of Bulletin.

[2] See fig. V.

[3] This form is a combination of fig. III with one of the twinned crystals of fig. V.

one to three thin lamellæ, twinned between crystals twinned parallel to the O-face.[1] On account of the developing of one crystal more than another, or the unequal development in different directions, forms, though in reality quite simple, appear at first very complex. For instance, a crystal in the collection and which will be readily recognized, has the appearance of two oblong rhombohedra placed parallel to a cleavage face, while a third crystal lies in the re-entrant angle. In reality two crystals are twinned parallel to the O-face, and one is so developed that it nearly shuts in the smaller one.[2]

A peculiar feature of all crystals is that the R-faces of the primary are all more or less roughened, the O-faces decidedly so, while the other R-faces and the scalenohedral planes are highly polished. In some crystals this seems to be simply due to etching, but in others to a subsequent deposition of matter of less purity. In this latter case the last addition has a milky opacity. Additions never seem to take place on any but the primary rhombohedral and zero planes.

Prof. Beck seems to infer that the roughness of these crystals is due to incipient solution on the surface. The results of my studies lead me to a different conclusion. A cleavage piece was taken from one of these roughened crystals and placed under a low power objective. The piece was then examined by reflected light. Focussing as nearly as possible and turning a bright ray of light on the fragment, the light was simultaneously flashed from a large number of the apparently rough points. On turning the stage about 90°, the light was again flashed from a large number of planes. As these planes were parallel to the cleavage lines of the crystal, it appears to me that this roughness must be referred to the regular development of the crystal in a manner analogous to the striæ on the prism faces of quartz.

In case of the milky coatings, however, though the roughness is again due to rhombohedral faces, there was evidently an interrupted growth of the crystal. This is evident, since between the crystal and its coating is a thin layer of iron pyrites. The secondary coatings are not, however, always of a less degree of transparency than the body of the crystal. In one or two instances the rhombohedron was developed, the growth interrupted, a deposition of cubical pyrite followed, and finally the crystal received fresh additions, but each of the rhombohedral planes was replaced by two sets of scalenohedral planes, thus giving the crystal the appearance of a tetrahexahedron. There

[1] Twinned lamellæ placed between the twinned crystals, fig. V.
[2] Fig. II gives a partial representation of this instance.

is one crystal of great beauty which shows these characteristics to perfection.

There is yet another form in which the calcite occurs. This, though not as interesting as the other, is yet worthy of notice. In this form the mineral appears in large, branching masses having much the appearance of coral. These branches are made up of fine scalenohedrons coating the surface of larger crystals. Among these branches are small, medium sized, and quite large crystals of celestite, a mineral very common in this locality.

According to Emmons, the vein in which these minerals occur cuts through a gneiss formation.

Associated with the calcite were found fine, large crystals of galenite; pyrite. in cubic and octahedral crystals; sphalerite (in many cases, crystals of exceptional beauty), and also celestite.

Though Rossie has, without doubt, produced the finest crystals, yet other towns in St. Lawrence county, have produced crystals remarkable on account of their size. The neighboring county of Jefferson has contributed the largest of any. In the Museum there is a fine, large crystal from Oxbow, a post-office in Antwerp township, measuring 12x10x10 inches. The crystal, though very bright and fresh looking, has been attacked by weathering. Very large and perfect scalenohedrons are also found in this locality. The Museum has good representatives of these also.

III.—PYROXENES FROM THE MINERAL LOCALITY AT CHILSON HILL, TICONDEROGA, N. Y.

The locality at Chilson Hill, Ticonderoga, Essex county, is the site of the old graphite mine of the American Graphite Co. The mine has now been abandoned for about thirty years. It was not abandoned on account of exhaustion, but the great depth, the great influx of water, together with the discovery of a new locality at Hague determined its shut-down for a time. Though the new mine at Hague yields a poorer grade of ore and is worked with greater difficulty, I am told that on account of the heavier minerals with which it is associated and which render washing and refining so much easier, the new workings pay much better. At Hague the graphite occurs in a gneiss vein. while at Ticonderoga it occurs in a gangue of calcite. It is this vein of calcite located in the gneiss which bears the minerals of this locality. Here as in nearly all mines what is valued by mineralogists

is to be found in the "dump." As the tunnels and drifts were run, the wall-rock encountered was thrown in one place while the "undressed ore" was carried to the surface and sorted. Lying as these sorted lumps have lain for so many years exposed to the weather, one would not expect to find minerals in a fresh condition, but the locality is more interesting on account of other things than the intrinsic value of the minerals. Yet it is of no rare occurrence to break a large mass of calcite and to find enclosed, perfectly fresh and undecomposed crystals of pyroxene.

The following is a list of the minerals found by me in this place: Pyroxene, scapolite, quartz, graphite, apatite, sphene, calcite.

The pyroxenes found here are peculiar on account of their size, the inclusions which they carry and their external appearance. There are at present, in the Museum, two of the largest ever found in the State and probably in the world. The largest of the two measures thirty-six inches in circumference and eighteen in length. The second one is about eighteen inches in circumference by twelve in height. Both crystals have their prism planes perfectly developed, the prism planes I and i-i (Dana) being both present and about equally developed. Basal planes in both cases are lacking, appearances favoring the idea that each is a fragment broken from larger crystals in blasting or in dressing the ore. They are badly decomposed, though as yet quite firm. The crystals are coarsely lamellar, parallel to O, the lamellæ varying in thickness from two to five mm. In external appearance they are very rough, though the indentations are not deep. These indentations are more like long, rather deep and interrupted striæ. It is rarely that the calcite causes a real indentation, though when in contact with quartz the pyroxene is always moulded around it, never penetrating it. In the fresher crystals which are broken from the calcite the latter mineral is found closely fitting into the striations, and has a peculiarly fine, granular, crystalline structure. The prism angles of all crystals are quite sharp, but when the crystals are terminated by pyramidal faces the interfacial angles are invariably rounded. In the body of the crystals, especially the larger ones, are enclosed rounded globules of well crystallized calcite and quartz. These masses vary in size from inclusions of microscopic dimensions to that of a walnut. Under these circumstances the calcite can be in no way distinguished from that outside the crystals. Graphite is a very common inclusion. Thin lamellæ of graphite occur within the body of the pyroxene and also gashing the exterior of the crystals. Large

as the crystals occur, they are not always to be found of extraordinary size. The mineral often occurs in exceedingly compact, tough masses, cleavage well developed, but with no trace of a crystal form, save when a mass of calcite is enclosed, when the surface in contact will have either prism faces or terminal faces well developed. Occasionally tough fragments of this nature will be found, thrown out by blasts, which show a passage from the tough, compact crystalline mass, with little or no calcite to a side of the block where will be a gangue of calcite literally packed with small, doubly terminated crystals of pyroxene. If a little care be exercised in breaking off a piece, a fragment can be obtained which, when treated with acid, will leave a perfect network of interlaced crystals of varying sizes.

Quartz is another mineral which occurs in this locality, and though neither beautiful nor rare in form, yet possesses much of interest to one who chooses to study it. It invariably occurs in forms which Emmons and others have denominated "fused." Exactly what is meant by this term does not clearly appear; but certainly, taken in its literal meaning, it is untenable, whether aqueous or purely igneous fusion is meant. Nor can I bring myself to believe the peculiar forms to be the result of partial solution. In general the crystals have the appearance of being water-worn, or of perfect crystals having been rolled until the angles are all more or less rounded. In some cases no crystal form can be distinguished, only globular or lenticular shaped masses are the result. These globules vary in size in the same mass of calcite. Again, it is of frequent occurrence that a rounded, "worn" crystal will be found an inch or more in length by one-half inch in diameter beside a slender crystal an inch or more in length but with a diameter of less than one-fourth. The angles of the smaller crystals will also be as perfect as those of the larger. In short, crystals will lie side by side, one nearly perfect, the other with no trace of angularity. It is also common to find large clusters of crystals, all having this "fused" or "worn" appearance and completely imbedded in the calcite. Lest I have not emphasized this latter idea, I will repeat that all of the quartzes thus far spoken of are completely imbedded in the calcite. The walls of many of the veins are lined by large patches, several feet square, of these crystals, having individual terminations, rounded as before, and with an unindividualized base. Deep indentations often occur in these crystals, amounting to more than one-half of their diameter. Crystals are often found with a saucer-shaped de-

pression where the apex of the pyramidal faces should be, while the pyramidal planes meet in a rounded edge about the depression.

The inclusions of quartz are confined exclusively to graphite. This latter mineral occurs gashing the quartz in the same way as it does the pyroxene.

Of the graphite but little need be said as in appearance it differs but little from the ordinary occurrence. Disseminated through the bodies of other crystals it occurs in the usual six-sided tablets. There is one form, which is quite frequent here, which Dana's Mineralogy describes as of rare occurrence. This is the radiated, globular mass. These globules, the size of a buckshot, have been found by Mr. Beecher and myself, and there are specimens of them in the Museum at Albany. They have not been found except in the calcite. The tablets enclosed in the calcite cut the prisms at all angles, and even when lying approximately parallel to any face, the graphite is apt not to lie in one plane, but to have a warped surface.

The scapolite group is represented by a mineral which is assumed, pending analysis, to be wernerite. It occurs in the usual simple form, but rarely with rounded angles. Microscopic sections show infiltrated veins of radiating chalcedony. Nearly all specimens are more or less decomposed. Apatite occurs here in such small quantities as hardly to deserve notice, yet, on account of its presenting the same "fused" appearance as the other minerals, it is mentioned. It has the same light green color as nearly all of the apatites found in the Laurentian limestones. About the same degree of transparency also obtains. In form they have the simple prism and pyramidal faces with the O-faces occasionally developed. They vary in size from crystals a foot in length with a diameter of from one to two inches, to slender crystals one-eighth inch in diameter and from one to two in length. The crystals occur usually in the calcite but are sometimes found modifying and being modified by contact with quartz and pyroxene. The mineral differs in this respect from all others noticed, in the fact that however irregular or "fused" its surface may appear it is always with a perfect polish.

Sphene occurs in crystals never more than one-half inch in length and of the usual simple form. Its occurrence is limited to the compact masses of pyroxene, or where pyroxene, calcite and graphite are intimately mingled.

It remains now to mention the calcite which occurs here. It is in reality the "veinstuff" or gangue of the mineral sought as well as

of the others. Though never found in perfect crystals, it is yet perfectly crystalline. In color it is a light straw yellow. It can often be cleaved in perfect rhombs from one to five inches across the face. On every rhomb, striæ run diagonally across the faces, indicating the fact that, as usual, the mass is twinned, not simple. In fact, many times the mass will part parallel to these twinning striæ rather than to the prism faces.

The appearance of the mineral is also much modified by its associations. Whenever enclosing another mineral, the cleavage surfaces always present a warped appearance. This warping varies directly with the size and number as well as with the variety of the mineral enclosed. In the first case, suppose the enclosed mineral, say a crystal of pyroxene, be very small: then the warping would be noticed with difficulty, if at all, whereas if the size of the crystal were increased the warping would extend over a surface of two or more inches across, with a departure from a straight line, at that distance, of nearly one-fourth of an inch.

In addition to the warping there will also be noticed a granulation extending various distances from the surface of the crystal. These granulations are nothing but smaller crystalline masses surrounding the enclosed mineral, which, for some reason, have not been free to assume the more coarsely crystalline state. This peculiar aggregation conforms closely to the shape of the enclosed crystals, though, as it reaches away from the enclosure, the angularity is lost. Unfortunately there was no opportunity to test this peculiarity in connection with the largest crystals, since they were wholly free from the calcite. If, however, the bulk of the surrounding calcite was not proportionate to the size of the crystals, the warping must have been very great.

Thus far the facts of occurrence, of these minerals as well as those from Newcomb, alone have been stated. The question now arises, do these facts warrant any other explanation than that of the fusion theory? It is difficult to understand how either dry, or aqueous fusion could have produced these results. In both cases it would seem that in cooling slowly they would have assumed their original form, if, indeed, we could safely assume a perfect form originally. This explanation is too complex, when a simpler one is at hand, which appears to answer every purpose. The explanation by the assumption of a partial solution appears to involve even greater difficulties. For, while there is no doubt that a sufficient degree of heat could be

obtained and an abundance of a solvent agent, it appears impossible to explain why the smallest crystals always have the most nearly perfect form, and that, even, when a large crystal and a small one lie close to each other in the gangue. If a large crystal of calcite be dropped in an acid solution together with a smaller one, it will invariably follow that the smaller will disappear first, and that it will wholly lose its external form before it so disappears. The same holds true of all easily dissolved minerals, and it appears safe to assume it true of minerals like quartz, pyroxene, apatite, etc., which are more refractory.

Again, the abundance of free silica present would render the accounting for the silica removed by solution a task by no means easy. Not only does the "country rock," which in this case is gneiss, contain much quartz, but the walls of the veins are in many cases completely covered with quartz crystals, "fused," and with their apices pointing towards the center of the vein. It would seem as if, had the solvent action been present, the silica would have been carried into the vein, not out of it, especially when such an abundance of bases existed in the form of lime.

It seems as if minerals could readily be divided into three classes. First, those formed by volatilization; second, those formed from solution; third, those formed by segregation in beds or veins while undergoing metamorphism. As examples of the first class crystals of sulphur formed in volcanoes, the different chlorides, etc., found under the same conditions, may be given, to which may, in all probability, be added the diamond. Minerals of the second class may be recognized by their fluid inclusions, such as quartz, and many may be formed artificially. Of the third class, the mineral constituents of rocks, such as granites, gneisses, diorites, may be given. Intrusive veins, dykes, and veins of segregation, whether metalliferous or not, would also come under this third division.

Among rocks that are wholly crystalline, it is impossible that their mineral constituents should be deposited from solution in the sense in which the word is usually employed. Each mineral, if indeed any individuals existed in the beginning, would be in a semi-fluid or pasty condition. As time went on each would separate more or less perfectly from the mass, and as nearly as possible each would assume its peculiar form. With large rock masses, however, which Rosenbusch designates as "hypidiomorphic-granular," individualization is rendered impossible from lack of space, and from the fact that the factors of solution are nearly the same in the case of each. In fact

the "allotriomorphic" and "riliomorphic," designated by the same author, could be explained by means of the well founded assumption of more rapid crystallization of some minerals than others.

From the well known homogeneity of granites and gneisses this inference can be legitimately drawn. At the same time, it is easy to imagine exceptions to these circumstances which would allow a mineral to assume its own form with greater or less perfection, and such exceptions are actually found. Let a cavity, however small, be formed in a rock undergoing metamorphism and it will bristle with crystals either of quartz, feldspar or mica or all together. It will also be readily called to mind that in coarsely crystalline rocks that the quartz is usually the gangue in which perfection of form most readily occurs. Minerals, such as spodumene, feldspar, beryl, triphyllite, tourmaline, etc., which are found at the spodumene locality at Huntington, Mass., have great perfection of form, irrespective of size, so long as they are developed in quartz, but at once lose their individuality when masses of feldspar and mica occur. It is quite rare to find these minerals in the feldspar and mica, but when they do thus occur they are invariably misshapen. To those who are familiar with the occurrence of zinciferous minerals in the calcite gangue of the Franklin Furnace and Ogdensburg zinc mines in New Jersey, additional facts will readily offer themselves. It is comparatively rare in these localities to find minerals in the gangue with sharp angles and perfected forms.

Among miners the term "shot ore" is employed to designate a mass of ore perfectly crystalline and well individualized save external form. This external form is produced by the great amount of mineral matter attempting to crystallize in a limited space. The phenomenon is noticed more frequently in iron and zinc ores, but it is by no means confined to them. In the garnet beds or pockets so abundant in Warren and Essex counties, N. Y., by far the greater number of these deposits break up in a manner exactly similar to the "shot ores" of the miners. In one place in Thurman, N. Y., a bed or pocket of hornblende is similarly formed.

Again the deformation and distortion of nearly every species of minerals, deposited from solution, in space, limited either by size of cavity or by interference with each other, are ample evidence that such distortion may occur from crowding. Evidence might be also adduced from the class of pseudomorphism where one mineral fills a cavity formed by another, which has been removed by solution. The same

line of reasoning would also be favored by the common explanation of infiltrated veins which have been "locked."

Finally I would say that there seems to me to be the best of reasons for discarding the explanation ordinarily adopted in all cases, namely, by corrosion or by imperfect crystallization, a worse explanation, which does not explain at all. In a vein of infiltration and in very many other individual cases, corrosion may be and probably is the correct explanation. But in veins of segregation, or in highly metamorphic rock masses where crystals occur with rounded angles and edges, neither "fusion" nor "corrosion" appear equal to the task which is set for them.

Explaining their forms, however, by saying that they are the result of crowding, or growing in a pasty mass, or of a general crystallization throughout the entire mass, clears away much that is otherwise hard to explain and affords at least an excellent working hypothesis.

EXPLANATION OF THE PLATE.

All the figures given in this plate are copied from drawings in Prof. Beck's Mineralogy of New York. These drawings were made from crystals in the possession of Prof. Emmons, and the crystals are now on exhibition in the Museum.

The crystallographic nomenclature has been changed to the corresponding symbols of Dana's "System of Mineralogy."

With the exception of fig. 1, each crystal is selected to illustrate one point only, and the crystal is drawn simply according to its primary form. For the rare planes so common to all of these crystals the reader is referred to the illustration in Dana's "System of Mineralogy."

Fig. I. Rhombohedron, with its edges replaced by scalenohedral planes.

Fig. II. Two crystals twinned parallel to i i; one crystal much larger and more perfectly developed than the other.

Fig. III. Two rhombohedrons twinned parallel to i-i.

Fig. IV. Rhombohedra in which the O planes are developed. This is frequently carried to such an extent that the crystal is reduced to a thin plate on which the rhombohedral planes are observed as mere bevelments.

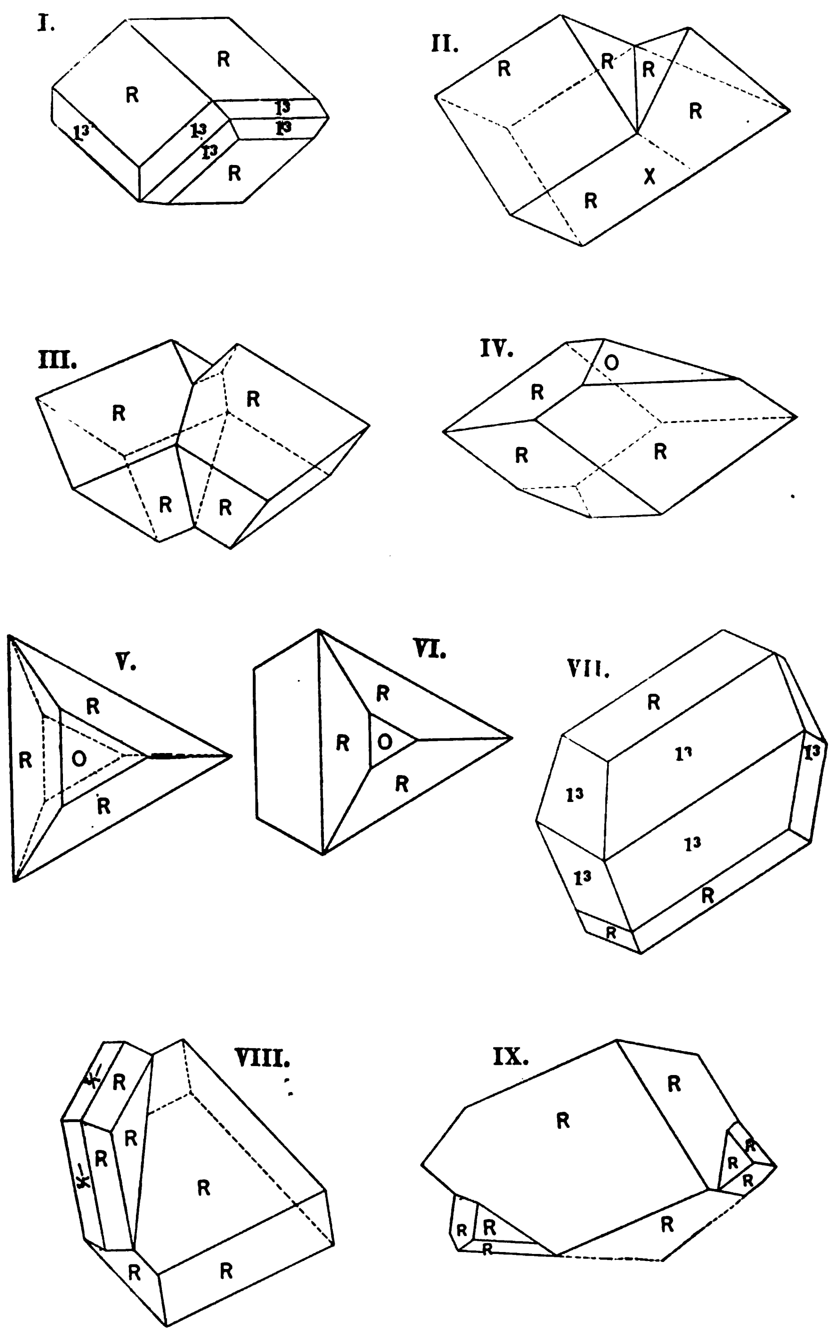
Fig. V. Two crystals twinned parallel to O. Crystals sometimes much distorted through unequal development.

Fig. VI. Distorted crystal of fig. V. The crystal is probably hemimorphic.

Fig. VII. Scalenohedral planes developed at the expense of the rhombohedral planes. The reverse of fig. I.

Figs. VIII and IX. Distorted and twinned crystals. These forms are common though much more complex.

PLATE I.



BULLETIN

OF THE

NEW YORK STATE MUSEUM

OF

NATURAL HISTORY.

No. 5.

November, 1888.

THE WHITE GRUB OF THE MAY BEETLE,

BY J. A. LINTNER, PH. D.,
STATE ENTOMOLOGIST.

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1888.

CUT-WORMS.

Ever since insect injuries were first talked of and written about in this country, much has been heard of the *Cut-worm*. Its literature, if collected, would probably be as voluminous as that of the Rocky Mountain Locust, *Caloptenus spretus*, a portion of which fills two thick octavo volumes, and a part of a third, of the U. S. Entomological Commission Reports; while the losses resulting from cut-worms, repeated as they are in each successive year, and occurring alike in every portion of the United States, would doubtless exceed those of the above-named insect. Despite the important role they play in agricultural affairs, they are permitted to prosecute their work steadily and persistently, almost unknown, many of them unnamed, and never attaining to the distinguished honor of being made the subject of discussion in a conclave of governors,† or the objects of investigation of a United States Government Commission.

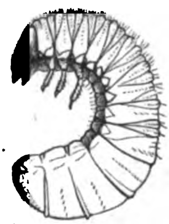

FIG. 1. — The White Grub of LACHNOSTERNA FUSCA (*Frohl.*).

True, more has been charged upon cut-worms than properly belongs to them. The secret manner in which they prosecute their work — under cover of darkness, and often beneath the surface of the ground — rarely permits them to be detected in their opera-

* At a conference of the Executives of the States and Territories suffering most from Locust ravages, held at Omaha, Nebraska, on October 25 and 26, 1876, the following were in attendance: Gov. Jno. S Pillsbury, of Minnesota; Gov. Samuel Kirkwood, of Iowa; Gov. Thomas A. Osborne, of Kansas; Gov. Silas Garber, of Nebraska; Ex-Gov. Robt. W. Furnas, of Nebraska; Gov. John L. Pennington, of Dakota; Gov. C. H. Hardin, of Missouri; and Prof. C. V. Riley and Prof. Cyrus Thomas, of the U. S. Entomological Commission.

tions, or the injuries inflicted to be unmistakably referred to them.

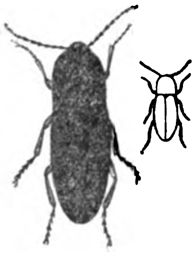

FIG. 2.—The Truncated snapping-beetle, natural size and enlarged.

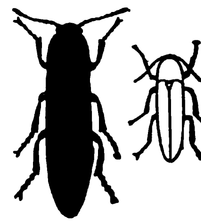

FIG. 3.—The common snapping-beetle, MELANOTUS COMMUNIS (*Gyll.*).

Roots are eaten and young blades and shoots are cut off, and the unknown depredator, as an easy solution of the mystery, is pronounced a cut-worm. Often in these cases, if proper examination were made, it would be found to proceed from the white grub, *Lachnosterna fusca*, shown in Fig. 1, or one of its many allied forms, or from some species of wire-worm — the larvæ of the "snapping beetles" belonging to the family of *Elateridæ* (two of the beetles are represented in Figs. 2 and 3). Such mistakes should not occur; they are inexcusable. Careful search would rarely, if ever, fail to bring to the light of day the author of these injuries; and when found, certainly after all that has been written and figured and gratuitously distributed upon entomological matters, every intelligent tiller of the soil in which these creatures lurk, should be able to distinguish between a white grub (Fig. 1), a cut-worm (Fig. 4), a wire-worm (Figs. 5 and 6), and a thousand-legged worm (Figs. 7 and 8) — the latter not even a true insect. Until this can be done, inquiry should not be made of how to destroy "the cut-worm," for the reply would be but a random shot fired in darkness.

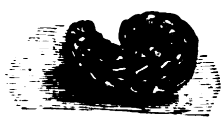

FIG. 4.—The W-marked cut-worm of AGROTIS CLANDESTINA (*Harris*).

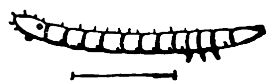

FIG. 5. — Wire-worm of Truncated snapping-beetle.

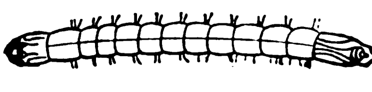

FIG. 6. — The common wire-worm. (After Fitch.)

WHAT ARE CUT-WORMS?

Cut-worms are caterpillars of moths that belong to the great family of *Noctuidæ*, which embraces a large proportion of our night-flying species of Lepidoptera. There are many different species — how many we are not able to state even approximately —

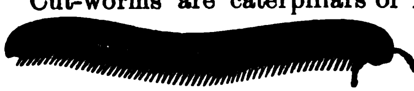

FIG. 7. — Thousand-legged worm, JULUS MULTISTRIATUS Walsh.

as the larvæ of very few of the mature forms (the moths) contained in the genera of *Agrotis*, *Mamestra*, and *Hadena*, to which they mainly pertain, have as yet been ascertained. About 350 United States species have been described in these three genera—*Agrotis*, embracing the larger number, and pre-eminently the Cut-worm genus. Of some of these, their habits are not such as entitle them to be numbered among the Cut-worms proper. We would prefer limiting this designation to forms having the appearance and habits of those known to English writers and agriculturists as *surface caterpillars*, and not extending it to those which seek their food mainly in trees or tall plants. Under such a limitation the class can be somewhat definitely circumscribed.

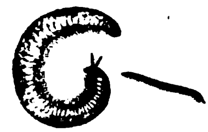

FIG. 8.—Thousand-legged worm—position at rest, and young

THEIR APPEARANCE.

The following are the principal features of the typical Cut-worms, by the aid of which it will not be difficult to recognize them:

When full grown, they measure from an inch and a quarter to nearly two inches in length. They are sixteen-footed (three pairs of true legs and five pairs of pro-legs or prop-legs), thick, tapering moderately at the extremities, naked and greasy-looking. In color they are dingy brown, gray or greenish, with indistinct, light and dark, longitudinal markings, and occasionally some oblique lines. The head is large, shining and usually red or brown. On the top of the first segment, or ring, is a horny plate, called "the collar" or cervical shield, and on the last, another smaller one, known as the anal plate, both of a shining and darker color than the rest of the body. On each of the segments are six or eight small, blackish humps or dots, each bearing a short hair, as shown in an enlargement of a segment in Fig. 9. When the caterpillar is taken from the ground, or otherwise disturbed, it curls itself into a ring, as represented in Fig. 4, or even more closely than this, with its head resting on its anterior prolegs, and the anal pair upon the crown of the first segment.

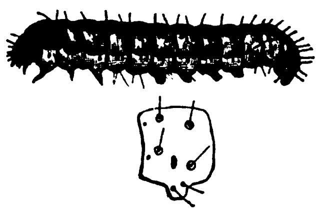

FIG. 9.—The Glassy Cut-worm, HADENA DEVASTATRIX (Brace).

Their Habits.

They are nocturnal in their habits, passing the day in concealment, in holes made by them in the ground among or near the roots of their food-plants, or in other shelter beneath stones, sticks, rails, decomposing leaves and grass, etc. A few of the subterranean species rarely if ever come to the surface, but cut off the tender blades beneath the ground, drawing them in as they are consumed or bearing the excised portion to their retreats to feed upon at leisure. Most of them, however, come forth from the ground after dark (sometimes by day in cloudy and damp weather), and with appetites sharpened by a protracted fast, make vigorous attack upon the young annual plants of the garden or the field, feeding upon their tips, or severing their stalks and destroying far more than they consume. If, during the time of their abundance, search be made for them at night with the aid of a lantern, hundreds of them may be discovered busily occupied in their destructive work. At the approach of day they retire to their hiding places, which may frequently be detected by the hole near the plant, made by them in reëntering the ground.

The time of their greatest injuries is when they are nearly full-grown, in the months of May and June.

Guenée, in his *Histoire Naturelle des Insectes — Species Général des Lépidoptères*, vol. v — Noctuelites, i, p. 258, has remarked as follows, upon the appearance and habits of the larvæ of the genus Agrotis:

Smooth, thick, with transparent skin and of dirty colors, furnished with elevated, shining trapezoidal spots, with the plates of the collar and the anus equally shining, and of a horny consistency they resemble worms or larvæ of insects far removed from the Lepidoptera. Their manner of living is not less marked. They do not confine themselves to hiding during the day under low plants; but they bury literally in the earth and among their roots, and when night arrives they do not often leave their tomb, except by projecting so much of the anterior portion of their body as is necessary to grasp their food. Several of the species are very destructive, especially by reason of their abundance, as *exclamationis*, *segetum*, *valligera*, *tritici*, *aquilina*, *obelisca*, etc. Their ravages are, however, less serious, by the fact that they usually attack the low plants, as *Plantago*, *Rumex*, *Taraxacum*, and the useless Gramineæ. Nevertheless, they are very dangerous guests of the gardens; it seems, even, that under certain circumstances they attack plants of very different families, and are not opposed to mounting during the night upon woody vegetation

M. Treitschke speaks of the ravages caused in 1833 and 1834, in the vineyards in the environs of Vienna by caterpillars of *aquilina*, which devoured the leaves, the blossoms and the buds, and I have myself seen roses attacked by the caterpillar of *segetum*.

HABITS OF THE MOTHS.

Most of them are nocturnal. A few species fly by day and may be found during the autumnal months feeding upon the nectar of flowers, as upon those of the golden-rod (*Solidago*). But by far the larger number come abroad only at night to feed, passing the day, in sleep probably, in various hiding places, as in crevices of walls, piles of wood and stone, under the bark of trees, behind closed blinds of dwellings where they have been attracted during the evening by lights—in short, in any dark, secluded place or crevice into which their closely-folded wings permit them to creep. Their entrance into crevices or apertures apparently too small for their admission, is facilitated by the habit belonging to many of the species of folding their front wings one over the other by the overlapping of their inner margin, and holding them almost parallel to the plane of position. In this attitude the greatest breadth of the moth across the folded wings exceeds but little the diameter of the body.

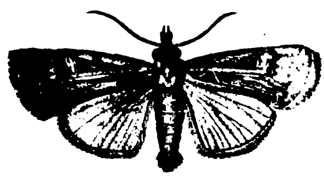

FIG. 10.—AGROTIS SUBGOTHICA, the Gothic Dart-Moth. (After Fitch.)

Although strongly muscular in their build, and capable of vigorous flight, when driven up from their concealment they fly but a short distance before they alight and seek a hiding place—much after the manner of the *Hesperidæ* among the butterflies, commonly known as "skippers." Fig. 10 shows one of the common species, the Gothic Dart-Moth, *Agrotis subgothica* (Haworth).

NATURAL HISTORY.

From the differences observed in the species known to us, it is not possible to give a satisfactory account of the life-history of cut-worms as a class. They require to be separately discussed. It may be stated, however, that the eggs from which the caterpillars proceed are placed usually upon some low plant, whence the young when hatched may easily reach the food that they require. It was formerly supposed, by Kollar and others, that the eggs were laid in the ground, but we are not aware of any

reliable testimony of their having been found in such places, while of some species the eggs have been discovered in locations quite removed from their natural food-plants, as upon the leaves and twigs of trees not known to be frequented by the larvæ, as are, at times, the eggs of *Agrotis saucia* (Hubn.), as shown in Fig. 11. The usual time for egg-deposit is the latter part of summer. Hatching soon after, early in the autumn, the larvæ enter the earth and commence to feed upon the tender roots of various plants—upon almost any kind that they encounter, as at this stage of their life they are very general feeders. At the commencement of winter as the frosts penetrate to their abode and chill them, and they have become about half grown, they descend into the ground to the depth of six or eight inches or even not so deep. Here they shape for themselves an oval cavity, within which they curl up in a torpid state for their winter's sleep. Freezing fails to harm them if undisturbed in their retreats. In the spring, when the frost leaves the ground, they awaken to activity, ascend to near the surface, and resume their feeding upon the roots of the starting vegetation. With their rapid growth, they soon attain to the size and strength that permits them to travel through the ground with ease in search of the particular food most agreeable to them.

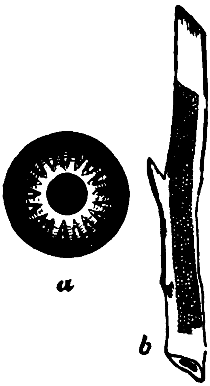

FIG. 11.—*a*, egg of AGROTIS SAUCIA, greatly enlarged; *b*, eggs of the same deposited upon a twig, natural size.

When full-grown they again descend into the ground to a greater depth than before, and within a compacted cell, made by packing the earth with their head, after the few days required to produce the change, throw off the caterpillar skin and become smooth, dark-brown pupæ. The pupal stage may average three or four weeks, when the moth issues from the rent pupal case and makes its way to the surface. During the brief life of the winged insect, which lasts only for two or three weeks, if not sooner terminated by one of its many enemies, the sexes come together, eggs are deposited for another brood, a moderate amount of food is partaken of in the nectar of flowers or other sweet substance, and the life-cycle is completed. A similar round, only much shortened in duration, and with continued progress, in some cases follows and is completed during the summer, but as a rule only a single brood of cut-worms is produced during the year.

In some of the species — in *Mamestra trifolii* (Rott.) and others, the life-history, as above given, differs, in that the hibernation is not in the larval stage, but as a pupa. The larvæ complete their growth in the autumn and enter upon the pupal stage in October and November. The moths of these species are those which are the first to appear abroad in the spring. [*Mamestra trifolii* is illustrated in Fig. 12, in three of its stages.]

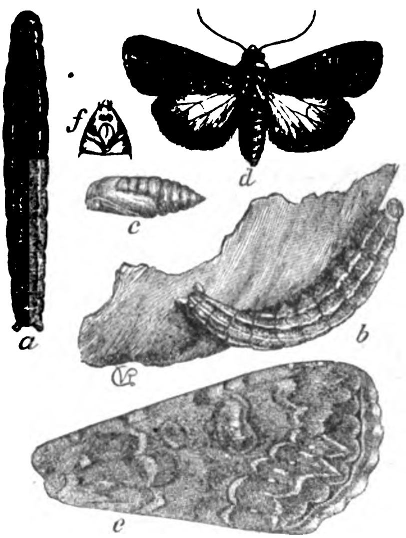

FIG. 12.—MAMESTRA TRIFOLII ; *a* and *b*, the Clover Cut-worm; *c*, pupa; *d*, moth; *e*, enlarged wing of the same; *f*, anal segment of the pupa.

CONDITIONS FAVORABLE TO CUT-WORMS.

The abundance of cut-worms is not dependent upon, or materially influenced by, the character of the soil. They are known to occur alike in gravelly soil, in loam, in clay, in sand, upon uplands and in alluvial bottoms. Their number does not appear to be increased by a high degree of fertility, for a cold and sterile location serves them as well, so long as it provides them with the requisite food-supply. Dr. Fitch states that he never found them more plenty than on one occasion among beans planted upon a hill-side, so barren that it was thought nothing else could be raised thereon. Nor does the kind of manure applied to the land seem to have any influence, except as it induces a more succulent plant-growth. A writer states, that he finds them more numerous on dry rolling ground. That this may not be accepted as the rule, appears from the statement of another, who says, "it has been observed that they damage crops more especially on wet lands," and he therefore recommends draining as a remedy.

With some of our insect pests, soil-conditions and character have much to do. Thus, we have recent evidence to lead us to believe that the rose-bug, *Macrodactylus subspinosus* breeds in wet, sandy land, and that a clayey soil is almost a preventive of its ravages. But with the ubiquitous cut-worm the soil is a matter of indifference — the vegetation that it bears, all-important. The

2

parent moth, with provident instinct, selects the locality for the deposit of its eggs that offers the most desirable food for its rapacious progeny.

Experience dearly bought, has taught us the food that they prefer, and its attendant conditions. A corn-field upon a newly turned sod is the metropolis of the cut-worm, while corn upon clover stubble, oat stubble, and wheat stubble, are places where they love to congregate.

THEIR FOOD-PLANTS.

In treating of so large a group of insects, and especially, one in which the several species are almost indiscriminate in their tastes, it can serve no useful purpose to present a list of all their known food-plants. A reference to such as suffer the most severely from their depredations, will be sufficient for the present paper.

Grass.— The amount of injury to grass lands from cut-worms, can only be conjectural, associated as it usually is with those of the white grub and allied species, wire-worms, the larvæ of the *Tipulidæ* or crane-flies, and of numerous other insects. It is, however, very great, for the first half of the active life of many of the species, is believed to be largely sustained by the food found in the roots of the various grasses — only taking upon themselves the true cut-worm habit when the coming of the young corn, cabbage, and tender garden vegetable invites, after their winter's rest, their greedy and wasteful attack. The extent to which they infest grass lands, is shown in the well-known experience that rarely if ever, is cut-worm attack so serious and so noticeable, as when corn is planted upon a newly-broken-up sod.

Corn.— The fondness of the cut-worm for corn, the most succulent of our grasses, has become proverbial; hence we have the following old distich giving the number of kernels to be planted in a hill:

> "One for the black-bird and one for the crow,
> Two for the cut-worm and three to grow."

Rarely is a corn-field exempt from its presence. Resulting at times only in a permissible, and perhaps, desirable thinning, yet frequently it compels an entire replanting. The extent of its injuries in some instances will be mentioned hereafter.

The following species, among others, are recorded as preying upon corn: *Agrotis clandestina, A. c-nigrum, A. subgothica, A.*

herilis, *A. messoria*, *A. saucia*, *A. tessellata*, *A. ypsilon*, *Hadena arctica*, *H. devastatrix*, *Laphygma frugiperda*, and *Nephelodes violans*. [Of these, *Agrotis clandestina* and *Hadena devastatrix*, two of the most common of the Cut-worm moths, and the most destructive to corn, are shown in Figs. 13 and 14.]

FIG. 13.—AGROTIS CLANDESTINA.

FIG. 14.—HADENA DEVASTATRIX.

Wheat.—Wheat is often injured to a serious extent by a species for a long time only known to us as a dingy-brown larva, with a conspicuous yellowish-gray band upon its sides. In several localities its attack had only been observed in instances where the wheat had been sown upon oat stubble (*American Entomologist*, i, 1868, p. 59). The larva was subsequently ascertained by breeding it, to be that of *Laphygma frugiperda*. Professor Riley had described it as the Wheat Cut-worm, in his first Missouri report. At the present time it is more generally known as the Army Cut-worm, from the abundance in which it at times occurs. For representation of the moth, see page 20, Fig. 23.

The European wheat fields often suffer enormously from two species, viz.: *Agrotis tritici*, the wheat dart-moth, and *Agrotis segetum*, the common dart-moth, which feed upon both the roots and leaves of winter wheat.

Barley.—A cut-worm, identified as *Agrotis declarata* Walker, caused considerable injury to barley fields (to oats also), in Manitoba, during the month of July of the year 1884. (Saunders, *Canad. Entomol.*, xvi, 1884, p. 206.) It is described as grayish-brown, with a semi-transparent skin, a brown horny head, and a shield of the same character on the upper part of the second segment; a pale line down the back, two similar lines along each side, and a white band lower down, close to the under surface.

Cabbage.—In a garden in Normal, Ill., containing 600 young plants, not over thirty escaped. The larvæ came out of the ground (in the middle of April), and cut off the plants at or near the surface, and then ate the leaves. The owner killed about 200 of the worms on the first day of their appearance, and 500 or more on the day following, after which the plot was reset with

late cabbages. The cut-worm was found to be *Agrotis annexa* (Treits.), shown in Fig. 15, in its three stages of larva, pupa and moth. (Forbes, *Twelfth Report of the Insects of Illinois*, 1883, p. 103.)

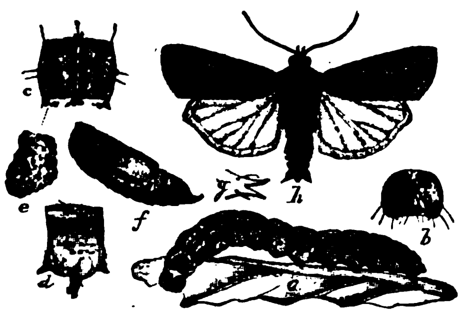

FIG. 15.—The Cabbage Cut-worm, AGROTIS ANNEXA: *a*, larva feeding; *b*, head; *c*, *d*, dorsal and lateral views of a middle joint, enlarged; *e*, portion of skin more enlarged to show spinous surface; *f*, pupa; *g*, enlarged anal tip of pupa; *h*, male moth.

In another locality, of 500 cabbage plants and 300 tomato plants set out a week later, but about 200 of each had escaped the cut-worm. A resetting shared the same fate. At least 500 worms were taken and killed from the cabbage plot, leaving them still numerous. (*Country Gentleman*, June 24, 1875, p. 392.)

A writer, inquiring for a remedy for the cut-worm so destructive to young cabbage plants, states incidentally, that *one-half or more of the young plants are cut down* in early spring, especially if the nights following their setting are cool or damp.

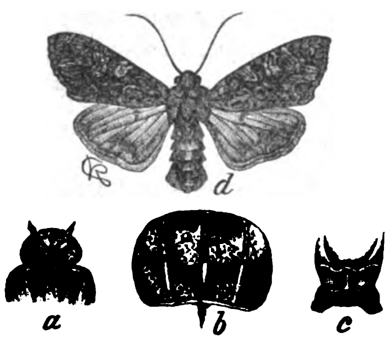

FIG. 16.—MAMESTRA SUBJUNCTA: *a*, head and collar; *b*, a middle joint; *c*, the anal shield; *d*, the moth.

Of the species preying upon cabbage are: *Agrotis clandestina*, *A. saucia*, *A. annexa*, *A. messoria*, *A. malefida*, *A. ypsilon*, *Mamestra subjuncta*, *Mamestra trifolii*, *Hadena devastatrix* and *Laphygma frugiperda*. *Mamestra subjuncta* (Gr.-Rob.), is illustrated in Figure 16, as one of the most injurious of the species to cabbage.

Turnips.—A favorite method of attack upon the turnip is to eat into and around the neck of the plant, until it is detached, or to eat off separate leaves and drag them into the hole beside the plant, to feed upon during the daytime. The turnip crop in England is more liable to cut-worm attack than is the crop in our country, the principal depredators being *Agrotis exclamationis* Linn., *Agrotis segetum* Ochs., *Mamestra brassicæ* Linn., and *Triphæna pronuba* (Linn.).

Onions.— Upon four acres of ground in Chautauqua Co., N. Y., onions had been cultivated for sixty years. In one of these years, the plot was sown and weeded out the second time, all standing well. The cut-worms commenced their work, and notwithstanding bushels of them were killed they cut off every onion, and on the fourth of July the land was plowed up for another crop.

Probably the most severe attack upon onions is that which was reported from Goshen, Orange Co., N. Y., early in June of 1885. A cut-worm was found to be rapidly destroying the crop, and to threaten the extinction in that vicinity of an industry, the annual value of which was stated to be half a million of dollars.

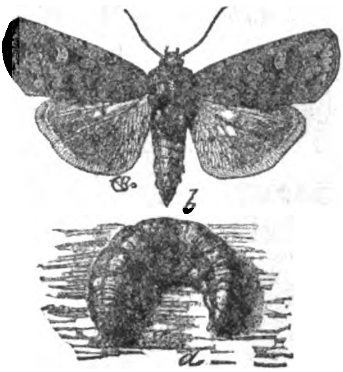

FIG. 17.—AGROTIS MESSORIA: the larva and moth.

The attack was investigated by the Entomological Division of the Department of Agriculture, and the insect engaged in it ascertained to be the "Dark-sided Cut-worm" *Agrotis messoria* Harris, represented in Figure 17, together with the moth that it produces. So abundantly did the worm occur, that according to the report of Mr. J. B. Smith made to the Department, "three little girls had picked in the morning a three-quart pail full. In one spot, less than fifteen inches square, forty full-grown larvæ were taken." In another report it is stated: "It is common for a family to pick ten or twelve quarts by day, and the same number at night by the light of lamps. These most industrious people have to work day and night to keep down these pests and save their crops." (See Professor Riley's Report in the *Ann. Rept. Commis. Agricul.*, for 1885, pp. 270–275.)

The crop in this locality suffered also severely from the above attack the following year (1886). The usual annual yield of the onion fields of Orange county, of from 500,000 to 600,000 bushels, was, it is estimated, reduced one-half (*Country Gentleman* for October 7, 1886, p. 750).

Beans.— The tender stems of young beans furnish tempting food, and every gardener knows the frequency with which the young plants are found in mornings with the stem severed in such a manner, as to leave no doubt of the presence of the cut-worm. The W-marked Cut-worm, *Agrotis clandestina* (Harris), is a common

depredator upon this plant. Dr. Fitch also describes the "Black-headed Cut-worm" as very destructive to beans, cutting them off slightly below the surface, and dragging the severed stem into the ground, where it buries itself, and there feeding upon it during the day, till the whole is devoured, or only pieces of the wilted leaves remain, plugging up the entrance to the hole (*First and Second Reports Ins. N. Y.*, p. 313).

Strawberries.— Mr. Wm. Saunders reports a severe attack of a species of *Agrotis* — the particular species is not named, although a full description of the larva and a brief one of the moth are given — upon plantations on the borders of Lake Huron, near Sarnia. The caterpillars manifested an especial fondness for the foliage of the strawberry, and notwithstanding the most vigilant search for them night after night, after they had been discovered as the depredators, and the collection and destruction of large numbers of them, they defoliated large patches of the vines to such an extent that they were utterly ruined. Nearly all through the month of June they literally swarmed, and scarcely a night passed without material damage from them. In one night, 1,800 of the caterpillars were killed by Mr. Mounjoy upon his beds (*Second Annual Report of the Entomological Society of Ontario*, for 1872, pp. 21, 22).

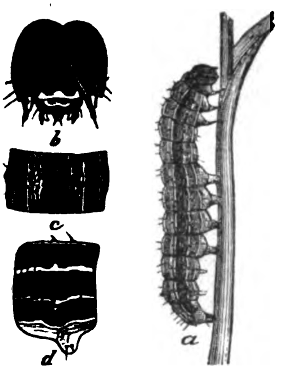

FIG. 18.—The Army Cut-worm, LAPHYGMA FRUGIPERDA, with enlargements of head and a segment.

Agrotis fennica, at an early stage in its phenomenal appearance in the spring of 1884, while but one-half inch in length, was found in Canada, by Mr. James Fletcher in large numbers, beneath strawberry plants, upon which they were feeding.

In the Southern States, *Laphygma frugiperda* (Sm.-Abb.), known there as the "Grass worm," has been injurious to strawberries (*Rept. Comm. Agricul.* for 1882, p. 138). It is shown in Figure 18.

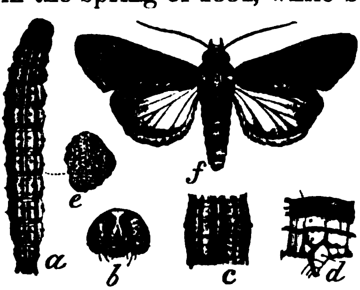

FIG. 19.—AGROTIS MALEFIDA: *a*, larva; *b*, its head enlarged; *c*, *d*, dorsal and lateral views of a middle joint; *e*, highly enlarged surface of skin; *f*, the moth.

Hops. —The operations of different cut-worms have frequently been observed on hop-vines, and they have

been turned up in the ground about the plants. So far as we know, but one of the species has been identified. It was found by Mr. Bennett, at Newton, N. J., feeding destructively on his vines and those of his neighbors. Sent to the Division of Entomology at Washington, it was ascertained to be *Agrotis malefida* Guen. — a species which is of more common occurrence in the Southern States than to the northward. In this instance, its injuries were arrested by dusting the vines with a powder made of gas-tar and lime. (*Bull. No.* 11. *Divis. of Entomol.— U. S. Dept. Agricul.*, 1886, p. 31.)

This cut-worm has also been found to be injurious to cabbage, and to a number of other plants. It is illustrated in Fig. 19.

Tobacco.—Young tobacco plants are often cut off in the month of June. In West Meriden, Conn., three thousand plants were set on June 22d. The next morning, from one row of one hundred and eighty plants two hundred and fourteen cut-worms were taken. Dr. Fitch records the fact of their particular fondness for this plant. He states: "I set out in my garden a few tobacco plants that I might notice what insects would come upon this filthy weed; and within a few days after, one of these cut-worms gave me a very palpable reminder that he would not tax me for cabbages and beans if I would only furnish him with what tobacco he wanted to chew" (*Sixth-Ninth Reports Ins. N. Y.*, 1865, p. 243).

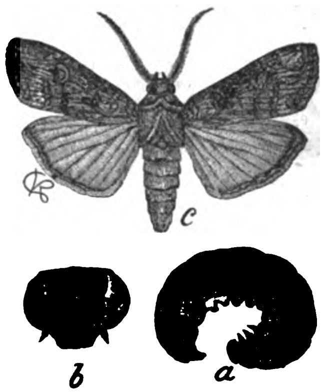

FIG. 20.—AGROTIS YPSILON: *a*, larva; *b*, enlarged head of same; *c*, the moth.

Figure 20 shows "the Black Cut-worm," and the moth that it produces, *Agrotis ypsilon* (Rott.), which is one of the species from the attack of which tobacco plants are known to have received severe damage.

Clover.—In the Ottawa district of Ontario, during the month of May, 1884, a cut-worm was discovered in large numbers and proving very injurious in clover fields. It was at first believed to be the army-worm, but upon rearing some of them to the perfect state, they proved to be *Agrotis fennica* (Tausch.) (Saunders, *Canad. Entomol.*, xvi, p. 204). *Agrotis malefida* Guen., also feeds on clover (Riley *in Rept. to Comm. Agricul.* for 1884, p. 292).

Cotton.— Early cotton — February planted, is frequently damaged by different species of cut-worms, particularly by the Cabbage Cut-worm, *Agrotis annexa* (Treits.). (*Bulletin* No. 1, *Dept. Agricul.— Div. Entomol.*, 1883, p. 44.) *Laphygma frugiperda* (Sm.-Abb.) is also injurious to cotton, according to Glover, who has illlustrated the insect in its different stages, and its earthern cocoon, in plate 9 of his MS. Notes — Cotton, under the name of the "Grass worm."

Smilax.— This beautiful and delicate twiner, *Myrsiphyllum asparagoides*, has been injured by the Variegated Cut-worm, *Agrotis saucia* (Hübn.), which has attacked it in conservatories in Lowell, Mass., and eaten off the softer parts and especially the top of the plant (*American Entomologist*, 1880, iii, p. 298). The worm and its moth are represented in Fig. 21. It is one of our commonest cut-worms, which is ever ready to attack almost any kind of tender vegetation, and has often been known to climb vines and feed upon their foliage. The moth was for a long time known as *Agrotis inermis* Harris, but later was ascertained to be identical with the *A. saucia* (Hübn.), of Europe.

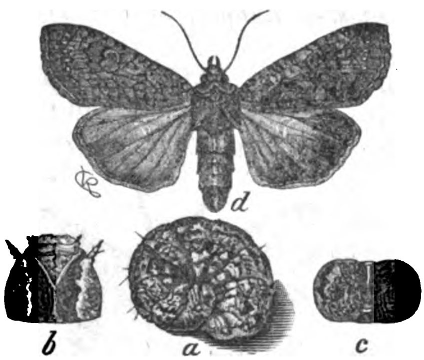

FIG. 21.— AGROTIS SAUCIA — *a*, larva; *b* and *c*, head and a middle joint of the same, enlarged; *d*, the moth.

Flowers.— In a bed of hyacinths, at Buffalo, N. Y., just as the flower buds had commenced to open, the flower-scapes were cut off — hardly one in five remaining.

Mr. William Saunders has noticed a special fondness of cut-worms for pansies. "Many fine plants of this flower of the previous year's growth were found, early in the season, eaten close to the ground, both leaves and stalks, and from about the roots of a single plant from thirty to fifty of the nearly full-grown larvæ were taken (*Canadian Entomologist*, 1880, xii, p. 189).

A gentleman writing for a cut-worm remedy, from Greenwich, R. I., states that nasturtiums, phlox, and carnations had suffered severely. Dr. Harris mentions asters, balsams, and pinks as often shorn of their leaves and of their central buds by these concealed spoilers (*Ins. Inj. Veg.*, p. 443).

Some beds of phlox bordering a carriage-way in New Jersey,

were found by Mrs. Mary Treat very attractive to cut-worms. "Untold numbers" were discovered feeding upon them when examined with a light in the evening, and upon turning over some of the ground beneath them, in one search over a pint of the worms were taken, from just beneath the surface (*Proc. N. J. St. Horticul. Soc.*, at 8th Meeting, 1883, pp. 88–9).

Among other garden and field crops which are liable to cut-worm attack, are peas, beets, potatoes, tomatoes, pumpkins, melons, and squashes.

ABUNDANCE OF CUT-WORMS.

As with other insects, these have their years of unusual abundance, for which we are not able to assign a satisfactory cause. Sometimes a single species only has multiplied, and one that had never before been known as injurious, as with the Bronze-colored Cut-worm, *Nephelodes violans*, in Northern New York, in the spring of 1881, and with the recent phenomenal appearance of the hitherto rare *Agrotis fennica*, in Northern Michigan and in Canada, in 1884. At other times all of the well-known species make their appearance in such force that it is next to impossible to interpose effectual resistance against their onslaught.

A few instances of their occasional abundance may be cited:

More than thirty cut-worms have been found around one hill of cucumbers.

In Sullivan county, Tenn., as many as sixty have been dug from a single hill of corn (*Report Commis. Agricul. for* 1872, p. 122).

"Bushels," are reported as having been taken from a large onion field.

Dr. Harris copies the statement without questioning it, although seeming almost incredible, that sixty bushels of mold taken from a buckwheat field where *Agrotis tritici* prevailed, contained twenty-three bushels of the caterpillars.

LITERATURE OF THE CUT-WORMS.

Dr. Harris, in the first edition of his admirable report, published in 1841, and entitled "A Report on the Insects of Massachusetts Injurious to Vegetation," prefaces his discussion of cut-worms, occupying fourteen pages, with this brief summary of the general ignorance of them at the time of his writing: "Numerous complaints have been made of the ravages of cut-worms among corn, wheat, grass, and other vegetables in various parts of the country.

After a tiresome search through many of our agricultural publications, I have become convinced that these insects and their history are not yet known to some of the very persons who are said to have suffered from their depredations."

Dr. Harris has given briefly their general habits, and refers them to the group of Noctuid moths known as *Agrotidians*, of which he presents the prominent features and characteristics. From a considerable number of cut-worms collected by him during the months of June and July, scarcely differing in appearance from one another, five different species of moths were obtained. One of these was the *Agrotis devastator* of Brace, and the other four were described and named by him as *Agrotis telifera*, *Agrotis inermis*, *Agrotis messoria* and *Agrotis tessellata;* of these the first two have since been found to be identical with *Agrotis ypsilon* Rott. and *Agrotis saucia* Engr. Quoting from letters of Dr. F. E. Melsheimer upon the "Corn Cut-worm," he gives additional observations of his own upon it, and names it *Noctua clandestina*. Several remedies for these pests are proposed and quoted from other writers. Another species, which cuts off the leaves of roses, currant bushes, and other shrubs and even young trees, is referred to *Hadena amica*, described by Stephens, as rare in England, but which had been previously described by Dr. Boisduval as *Hadena arctica*.

In the *Second Report on the Insects of New York* (*Trans. N. Y. State Agricultural Society* for 1855, xv, pp. 542–550, and pp. 310–318 of the First and Second Reports, published in 1856), Dr. Fitch treats of the cut-worms — "the larvæ of different species of *Agrotis* that sever the young stalks of Indian corn by night at or near the surface of the ground." The moths that they severally produce were still unknown, as no success had attended the efforts to rear the larvæ in confinement. Five kinds had been observed by him preying upon corn, which he briefly describes, with their habits, under the names of the Red-headed Cut-worm (cutting the plants below the surface of the ground), the Striped Cut-worm (cutting the plants half an inch above the ground), the Faintly-lined Cut-worm (more common among onions and cabbages), the White Cut-worm (rare among corn and beans), and the Black-headed Cut-worm (destructive to beans, cutting them below the surface and drawing the severed stem into its hole). Three species of Cut-worm Moths are also described, figured and their habits given, viz.,

Agrotis subgothica (see Figure 10), *Agrotis devastator* (a *Hadena* Figure 14), and *Noctua clandestina* (an *Agrotis*, Figure 13). As natural enemies of the cut-worm, the crow, the larva of one of the ground beetles—*Harpalus caliginosus* (see Figure 26, p. 25), and a hymenopterous insect like the black wasp, are mentioned. Useful preventives and remedies are thick planting, digging out by hand, and trapping in holes.

In Dr. Fitch's *Ninth Report on the Insects of New York* (*Trans. N. Y. State Agricultural Society* for 1863, xxiii, pp. 804-817, and *Sixth to the Ninth Reports*, 1865, pp. 237-250), in connection with general remarks upon cut-worms, the "Corn Cut-worm" is treated of in minute detail of description, habits, etc., under the name of *Agrotis nigricans* var. *maizi*. The species has since been identified as *Agrotis tessellata* Harris. It is represented in Fig. 22, in its natural position at rest, and with wings expanded in flight.

FIG. 22.—Moth of the Striped Cut-worm, AGROTIS TESSELLATA. (After Fitch.)

A like minute account of the "Yellow-headed Cut-worm" is given, from which "*Hadena amputatrix*" of the Third report, was reared, now known as *Hadena arctica* Boisd.

The larva of a common carabid beetle, *Calosoma calidum* (Fabr.), shown in Figure 25, page 24, is also described and figured, as one of the most efficient destroyers of cut-worms. Its method of attacking, killing and devouring its prey is graphically detailed, and characterized as "one of the most interesting and wonderful exhibitions of insect economy which the world affords."

Mr. B. D. Walsh, in the *Practical Entomologist* for June, 1886, i, pp. 85–6, has devoted about two pages to the habits of cut-worms, and notice of four species of *Agrotis* and two of *Hadena*. An account by Mr. Cochran of some climbing cut-worms in Illinois is quoted, and mention made of a species infesting vineyards in California, and causing serious loss by cutting off the stem of the leaf.

On pages 64–66 of vol. ii of the same publication is an article entitled "Do Cut-worms destroy tree-buds?" where the affirmative observations of the writer are given, together with some expedients adopted for the destruction of these creatures.

In the *First Annual Report on the Insects of Missouri*, published in 1869 (pp. 67–91), Prof. Riley adds materially to our knowledge of these insidious depredators, in an article entitled "Cut-worms: The Natural History of Twelve Distinct Species." Of these, four are described as "climbing cut-worms," from their habit of ascending trees at night to feed upon the buds and leaves. They have been found abundantly upon apple and pear trees, especially upon the dwarf varieties and upon grapevines, preying upon the buds. They also attack the blackberry. the raspberry, currant, and rose bushes. The transformations of ten species are given, together with figures and descriptions of the caterpillar and the moth; and two other species, previously described in their several stages by Dr. Fitch, are referred to. A wheat cut-worm is also described and history given, which subsequently proved to be *Laphygma frugiperda* Guenée. The moth is shown in Figure 23, and its larva in Figure 18. The natural enemies and remedies for these destructive creatures close the notice.

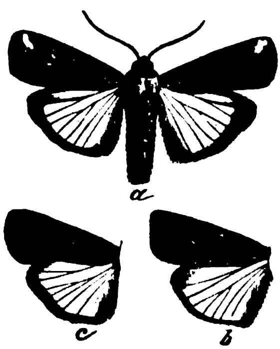

FIG. 23.—LAPHYGMA FRUGIPERDA and varieties.

Dr. Packard, in his *Guide to the Study of Insects*, 1869 (pp, 305–310), introduces figures of a few of the more common species, and quotes from the writings of Dr. Harris and Prof. Riley.

In the *Seventh Annual Report on the Insects of Illinois*, published in 1878 by Dr. Cyrus Thomas, Prof. G. H. French presents, in connection with his study of corn insects, a paper of twenty pages (pp. 81–100) upon the Cut-worms of the Field and Garden. Some general remarks upon these insects are followed by mention of natural and artificial remedies and by remarks upon the habits and characteristics of twelve species.

In the same report (pp. 202–219) Prof. French has given a second notice of cut-worms, in which descriptions of the moths of fourteen species appear, and of the larvæ of most of them, together with observations upon the habits, etc., of several of the species made by himself and by Mr. C. E. Worthington, of Chicago, Ill.

In the *Report of the Entomological Society of Ontario* for the year 1879, pp. 37–46, is a paper on "Canadian Cut-worms," by Mr. G. J. Bowles, of Montreal, in which twelve species are noticed,

described, and habits recorded of some, and remedies given. They are nearly all those which had been previously treated of by Professor Riley.

In an article entitled "Cabbage Cut-worms," contained in the Report of the Entomologist to the Commissioner of Agriculture, for the year 1884, Professor Riley has given a brief account of cut-worms in general, the best approved remedies for them, and excellent notices, averaging over a page each, of eight species that depredate on the cabbage, each of which is finely illustrated, as may be seen from the figures, which, through the kindness of the Commissioner of Agriculture, we have been able to present in the present paper.

The above are, we believe, the principal publications upon cut-worms accessible to the general reader. Reference to several other writings upon those which are injurious to Indian corn, may be found in a paper prepared by Mr. Thomas F. Hunt, and published in *Miscellaneous Essays on Economic Entomology by the State Entomologist of Illinois and his Assistants*, 1886, pp. 64-66.

LIST OF SPECIES.

As previously stated, no approximation to a full list of our cut-worms can as yet be given, since the larval stage and habits of so few of the species of *Agrotis*, *Mamestra*, and *Hadena*, are yet known. It would not be safe to presume, to any extent, upon a genetic identity of habits, since marked differences have been observed. For example, *Agrotis c-nigrum* (Linn.) and *A. bicarnea* (Guen.), according to Mr. S. L. Elliott, have been seen feeding by day, without any concealment, on chicory, *Cichorium intybus*. *Mamestra picta* Harris, the zebra cabbage worm (shown in Figure 24), feeds exposed, in dense clusters, when young, upon several of its food-plants, scattering with age, but continuing to feed by day without

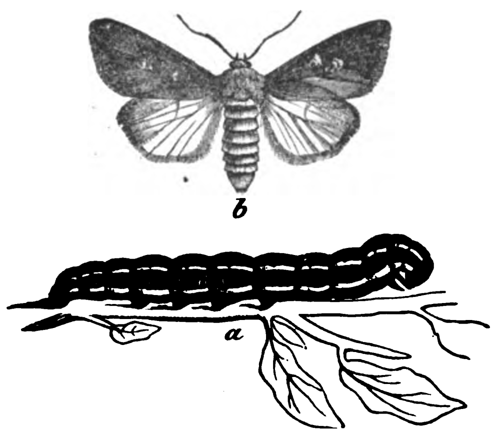

FIG. 24.—MAMESTRA PICTA Harris.

concealment. *Hadena adjuncta* Boisd., has not cut-worm habits, but finds its food at all hours of the day in the blossoms of the golden-rod (*Solidago*). *Hadena turbulenta* (Hübn.) feeds socially on *Smilax* at times, so abundantly as to defoliate it.

The following are the species of cut-worms, so far as known to me (twenty-eight in number), occurring in the State of New York:

The Spotted Cut-worm	Agrotis	c-nigrum (*Linn.*).
	A.	bicarnea (*Guen.*).
The Streaked Cut-worm	A.	haruspica *Grote.*
	A.	baja (*S. V.*).
The Black-lined Cut-worm	A.	fennica (*Tausch.*).
The Dingy Cut-worm	A.	subgothica (*Haw.*).
	A.	tricosa *Lintn.*
The Western Striped Cut-worm	A.	herilis *Grote.*
The White-headed Cut-worm	A.	plecta (*Linn.*).
The Grape-bud Cut-worm	A.	cupida *Grote.*
The W-marked Cut-worm	A.	clandestina (*Harris*).
The Dark-sided Cut-worm	A.	messoria *Harris.*
The Striped Cut-worm	A.	tessellata *Harris.*
	A.	declarata (*Walk.*).
The Cabbage Cut-worm	A.	annexa (*Treits.*).
The Shagreened Cut-worm	A.	malefida (*Guen.*).
The Black Cut-worm	A.	ypsilon (*Rott.*).
The Variegated Cut-worm	A.	saucia (*Hübn.*).
The Grass-green Cut-worm	A.	lubricans (*Guen.*).
The White-bristly Cut-worm	Mamestra	renigera (*Steph.*).
The Speckled Cut-worm	M.	subjuncta (*Gr.-Rob.*).
The Clover Cut-worm	M.	trifolii (*Rott.*).
The Yellow-headed Cut-worm	Hadena	arctica *Boisd.*
The Glassy Cut-worm	H.	devastatrix (*Brace*).
	H.	lignicolor (*Guen.*).
	H.	sputatrix *Grote.*
The Army Cut-worm	Laphygma	frugiperda (*Sm.-Abb.*).
The Wheat Cut-worm	Prodenia	commelinæ (*Sm.-Abb.*).
The Bronze-colored Cut-worm	Nephelodes	violans *Guen.*

In a revision of the present paper, it is proposed to notice each of the above species in some detail, presenting figures (of many), their synonomy and references to publication, descriptions of the caterpillar and moth, habits, time of appearance, and geographical distribution.

The following species, there is reason for believing, may be added to the above list, when their larval habits are ascertained:

Agrotis Normaniana *Grote.*
Agrotis alternata *Grote.*
Agrotis prasina (*Fabr.*).
Mamestra mucens (*Hübn.*).
Mamestra confusa (*Hübn.*).
Mamestra lorea (*Guen.*).
Luceria passer (*Guen.*).
Hadena apamiformis (*Guen.*).

Hadena verbascoides (*Guen.*).
H. cariosa (*Guen.*).
H. sectilis (*Guen.*).
H. vulgaris (*Gr.-Rob.*).
Hadena finitima (*Guen.*).
Hyppa xylinoides *Guen.*
Helotropha reniformis *Grote.*
Apamea nictitans (*Linn.*).

NATURAL ENEMIES.

As would naturally be expected from their numbers, their size, and their smooth bodies, the cut-worms have many natural enemies, whose persistence in seeking for them and making them their prey, greatly mitigates the injuries that their unchecked increase would otherwise inflict upon us. Of these, only a few will be referred to in this paper.

The nocturnal habits of most of the species render them much less liable to become the prey of our insectivorous birds than those that feed by day without concealment, yet they are far from enjoying entire immunity.

The Robin. — Foremost among the birds as a cut-worm destroyer, the robin (*Merula migratoria*) claims position. Mr. F. H. King, in his *Economic Relations of Wisconsin Birds*, forming chapter xi of vol. 1 of the *Wisconsin Geological Survey* (1883), has written as follows of it:

"Its eminently terrestrial habits, its fondness for larvæ of various kinds, and its ability to obtain those which are hidden beneath the turf, give it a usefulness in destroying cut-worms which no other bird possesses in the same degree, and for this feature in its economy alone, its greater abundance should be encouraged.

"Early in the morning, and toward the close of the evening, the Robin may often be seen searching after cut-worms in lawns, pastures and meadows, and when thus engaged, it hops about gazing apparently more at distant objects than searching for something near at hand; then, suddenly, it commences tearing up the old grass and turf with its bill; and, in another instant, it stands triumphant with its wriggling prize in its bill, for it rarely digs in vain. I have seen a Robin capture in this manner five cut-worms in less than ten minutes; and five other birds within view were doing the same work. * * * How the Robin discovers these cut-worms is not easily explained. It is possible, however, that the larvæ, while gnawing at the bases and roots of the grass stems, while secreting themselves after their night's raids, or while, toward evening, they grow restless and hungry, the slight movements which they produce among the grass are sufficient to betray their

hiding places to the Robin. It should be observed in regard to these cut-worms, that large numbers of them are destroyed by various birds just after showers and during cool, drizzly and lowery days, when the absence of the scorching rays of the sun, enables them to feed with quite as much comfort as during the night.

"From the stomach of one Robin were taken seven cut-worms, 1.25 inch long."

Prof. Forbes, State Entomologist of Illinois, in the examination of the contents of the stomachs of nine Robins, made during the month of May, found that cut-worms were extraordinarily prominent in their food, making twenty-eight per cent of the whole. Half of them consisting of a single large injurious species, *Nephelodes violans* (*Bulletin No. 6, Illinois State Laboratory of Natural History,* 1882, p. 4).

The Cat bird.—The same food has been found in the stomach of this species, *Mimus Carolinensis* L. (*id., ib.*).

In the examination of the stomachs of several young Cat-birds, Mr. C. M. Weed determined sixty-two per cent of the contents to be larval noctuids, and mainly of cut-worms (*Note from the Entomological Laboratory of the Michigan Agricultural College,* 1884, p. 21).

The Red-winged Black bird.—Prof. Forbes has also taken cut-worms from the stomach of this bird, *Agelæus Phœniceus* L., in Illinois.

The Purple Grackle.—Mr. King notes of this Grackle, *Quiscalus purpureus,* that it often follows the plow in quest of grubs and cut-worms (*loc. cit.*, p. 552).

Poultry.—Chickens, especially, are very efficient destroyers of cut-worms, in gardens, where they search for, and are quick to discover, them in the upturned ground. A large orchardist has stated that he would not have been able to cope with the worms that attacked his trees without availing himself of the services of a large brood of chickens procured for the purpose (*First Report of the Insects of Missouri,* p. 90).

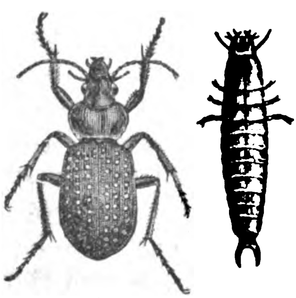

FIG. 25.—CALOSOMA CALIDUM: *a*, the larva; *b*, the beetle.

Calosoma calidum (Fabr.).—The larva of this ground-beetle, previously referred to on page 19, which preys upon many

different species of caterpillars, is so destructive to cut-worms, attacking them with so much energy, even if the worm be twice its size, that it has been designated by Dr. Shimer as the "Cut-worm Lion." Figure 25 represents the insect at *a*. For an interesting account of the operations of this powerful and ferocious larva, in searching for the cut-worms that constitute so large a portion of its food, its manner of seizing the worm, and its subsequent combat with it, see Dr. Fitch in *Sixth–Ninth Reports on the Insects of New York*, pp. 249-250.

Harpalus caliginosus (Fabr.).—The larva of this species is also a persistent and efficient enemy. Its strange, irregular form and ferocious habits have given it, in some localities, the name of the "Cut-worm's dragon." "When not glutted with food, it is running about incessantly in search of these worms, and slays them without mercy, with its powerful jaws seizing them commonly by the throat, and regardless of their violent writhings and contortions, sucking out the contents of their skins" (Fitch). [Figure 26 represents the larva of a *Harpalus*—possibly of this species—in the act of devouring a curculio grub.] Others of the *Carabidæ* feed largely upon them. Professor Forbes has found the remains of *Agrotis annexa* Treits. in the stomachs of *Pterostichus permundus* (Say), *P. Sayi* Brullé, and *P. lucublandus* (Say), and remains of undetermined species in *Chlænius erythropus* Germ., in the proportion of one-third of the entire contents (*Twelfth Report on the Insects of Illinois*, 1883, pp. 110, 111).

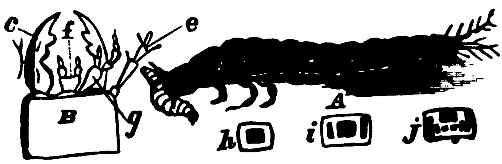

FIG. 26.—*A*, Harpalus larva, devouring a curculio larva. *B*, head seen from beneath, showing at *c*, the upper jaw (*mandible*); at *g*, the lower jaw (*maxilla*); with its four-jointed feelers (*palpi*); at *f*, the lower lip (*labium*), with its two-jointed feelers (*palpi*); and at *e*, the *antenna*; *h*, *i*, *j*, marks on the abdominal segments beneath. (After Walsh.)

An undetermined species of insect—"somewhat resembling the black wasp, but longer, shaped somewhat more like the hornet, but of a shining black," has been observed eagerly searching for the worms, even digging for them in the soil with its front legs, and drawing them forth, and stinging them fatally. Leaving them to die, it would subsequently return and excavate a hole in the ground in which to bury them, and heaping a mound over them (*Albany Cultivator*, vol. v, p. 18).

Podisus spinosus (Dallas).—This carnivorous Hemipter, known from its belligerent propensities as the "spined soldier-bug," will fearlessly attack young cut-worms much exceeding it in size, and take their lives by sucking their juices through its formidable proboscis—shown in enlargement in Figure 27.

FIG. 27.—PODISUS SPINOSUS (Dallas). *a*, the beak or proboscis enlarged; *b*, the insect, with one wing extended.

Uropoda Americana Riley.—Prof. French has observed this mite preying upon the Variegated cut-worm, while tightly fastened to it by means of a peculiar stiff, elastic pedicel or cord proceeding from the anal portion of its body, which Dugés has thought to consist of the viscous and dried excrements of the animal (*7th Rept. Ins. Illinois*, p. 218, and *Murray's Economic Entomology*, p. 163).

Spiders are also known to attack and kill cut-worms in their immature stages of growth.

The Toad.—Mr. Wm. Brodie, of Ontario, regards the toad as deserving of protection and introduction into gardens from its habit of coming abroad at night and devouring the cut-worms which are then seeking their food upon or near the ground.

Mr. E. W. Allis, of Adrian, Mich., reports his having taken on June twelfth thirty-three cut-worms from the stomach of a wart-toad, *Bufo Americanus* (*Thirteenth Report State Horticultural Society of Michigan*, 1883, p. 16).

PARASITES.

The partial immunity of cut-worms from destruction by such of their natural enemies as are above mentioned, resulting from the concealment in which the larger part of their lives are passed, attends them also in preserving them, to a great extent, from the attack of those parasitic foes which serve so important a purpose in diminishing the numbers of our insect pests. Yet, as the white grub, *Lachnosterna fusca*, is pursued and discovered in its subterranean burrows by its enemy, *Tiphia inornata*, and as *Tremex columba* falls a victim to the Thalessas, although deeply buried within the trunk of maple, oak or elm, so, also, are these nocturnal marauders of our gardens and fields compelled to succumb before the fatal thrust of the ovipositor of their commissioned parasitic foes.

As few, however, of the cut-worms have been studied during their larval stage, we know, as yet, almost nothing of the extent to which they are parasitized, or the names of the species that prey upon them. One of the species, *Nephelodes violans* Guen., studied recently in connection with its appearance in remarkable numbers in St. Lawrence county, N. Y., was found to be very subject to parasitic attack. Larvæ that I attempted to rear gave me many Tachinid puparia and two different hymenopterous pupæ (1*st Rept. Ins. N. Y.*, 1882, p. 109). Prof. Riley states of the same larvæ: "Of nineteen specimens placed in a vivarium * * * several proved to have been parasitized; one had nineteen *Tachina* eggs upon it [after the manner shown in Figure 28]; another gave forth *Microgaster* larvæ, which had spun their white cocoons in a surface cavity in the ground made by the larva, and still another gave an *Ophion* cocoon" (*ib.*, p. 103). Of other species, Mr. William Saunders has written as follows: "Cut-worms have been very abundant in the neighborhood of London during the spring [of 1880]. * * * When I reared a number of the larvæ with a view of breeding the moths, I found them so affected with parasites that I did not get a single moth, so that, although the larvæ were exceedingly abundant, the moths proceeding from them were comparatively rare, and all through the agency of the parasites" (*Ontario Agricultural Commission Report*, 1881, p. 219).

FIG. 28.—NEMORÆA LEUCANIÆ; the larva, fly, and puparium; also, its eggs placed upon the forepart of an army-worm, on which it is parasitic.

The following parasites are reported by Professor Riley as having been obtained by him: *Paniscus geminatus* Say—a large, yellowish-brown Ichneumon fly—its source not stated; *Nemoræa leucaniæ*, Kirkp., shown in Figure 28, from *Laphygma frugiperda* (Sm.-Abb.); and *Tachina archippivora* Riley, from an unknown cut-worm resembling that of *Agrotis subgothica* (Haworth).

Another *Tachina* fly was bred from the Black-lined Cut-worm, *Agrotis fennica* Tausch., during its recent abundance in Northern Michigan (in the months of April and May, 1884), and has been named and described by Dr. Williston as *Scopolia sequax* (Cook's *Notes on Injurious Insects—Entomolog. Laboratory, Mich. Agricul. Coll.*, 1884, pp. 5–6, figs. 5, 6).

Mr. Jno. G. Jack, of Chateaugay, Quebec, has reared from a dead cut-worm (species unnamed) a large number of minute Hymenopterous parasites, belonging to the *Chalcididæ*, which he has identified as *Copidosoma truncatellum* Dalman, a figure of which is given in the Report of the Commissioner of Agriculture for 1883 (Report of the Entomologist), pl. xi, figure 6 (*Canadian Entomologist*, xviii, 1886, p. 23).

Another chalcid parasite, *Copidosoma celænæ*, has been described by Mr. L. O. Howard (*Bull. No.* 5, *Bureau of Entomology — U. S. Dept. Agriculture*, 1885, p. 11), as having been reared, in the female only, in large numbers, from *Mamestra renigera* Steph., collected as St. Louis, Mo.

PREVENTIVES AND REMEDIES.

Quite a large proportion of the voluminous literature of cut-worms to which we have referred, as distributed throughout our agricultural journals, consists of methods of prevention and remedy, almost every one of which we are asked to accept as effectual, and very many of them as "superior to all others." And still the cut-worm remains with us and obstinately refuses to be exterminated.

It is not the purpose of this paper to present a compilation of what has been written upon the subject, but rather to give an abstract of what is known upon it. Nothing, therefore, would be gained by referring to the many remedial measures proposed which have not stood the test of experiment, or to those which do not give promise of accomplishing the desired results inexpensively and with that amount of labor which can easily be spared from the other pressing duties of the opening agricultural year.

The following are some of the methods that we deem the most valuable:

Salt.— A correspondent of the *Country Gentleman* [E. H.], from Chester, Pa., gives the following method of protection by the use of salt, which, after having tested its efficacy for several years, he pronounces "cheap, of easy application, and *perfectly sure:*"

"Immediately after the corn is planted, sprinkle on the hill over the covered grains, about one tablespoonful of common salt to each hill."

The explanation given for the protection of the plants is, that the salt as dissolved by the rain, dew or other atmospheric moisture, is carried down to the roots and taken up by them into the circulation; and that although salt in itself will not injure cut-worms even

if they be buried in it, they will not eat young corn if there is a little salt in its sap.

Should the salt not be applied until after the corn has shown itself above the ground, it might kill the plants: applied as above directed, it will do no harm. (*Country Gentlemen*, for Feb. 27, 1873, p. 132, c. 2–3.)

Another method of protection with salt is said to be, to soak the seed corn in a strong brine for twenty-four hours before planting. It is asserted that it prevents it from being eaten in the ground, and hastens its germination by from one to two days. This may prove to be quite as effectual in protecting from cut-worm as the application of salt upon the ground.

A writer in the *Rural New Yorker* (Feb. 18, 1888, xlvii, p. 108) prevented injuries to corn, in a field which upon plowing he found "alive with half-grown cut-worms," by sowing broadcast over the field, the day after its planting, 250 pounds of salt to the acre. Not a single hill was cut by the worms.

Copperas.—The publication of the first of the above methods called out the following, which the writer thinks "is more easily applied and equally effective," as it had been employed by himself and others for twelve years, and always with success, even upon new ground and clover land. It had been tested by planting portions of fields without the preparation, and these portions, in several instances, required replanting two or three times:

"Put the seed corn in a tight tub or barrel, and pour in enough water to keep it well covered after it swells. For each bushel of corn add a pound or a pound and a half of copperas dissolved in warm water. Stir well, and allow the corn to remain in the copperas water twenty-four or thirty hours. Stir several times while soaking. Then take out and sprinkle a small quantity of land-plaster over — enough to prevent the grain from sticking together — and plant. When prepared as directed, if a change should occur in the weather to prevent planting, the corn may be spread out upon a floor and allowed to remain until good planting weather. It will turn black in drying, but that does not matter" (*Country Gentleman*, for March 20, 1873, xxxviii, p. 179, c. 2–3).

Saltpeter.— A saltpeter solution has been recommended for pouring about the roots of plants infested with cut-worms. It is said to kill the pests while at the same time it operates as a nitrogenous fertilizer, aiding the plants to resist attack.

Hellebore.— An experiment with hellebore dissolved in water has proved entirely successful in protecting young tobacco plants from the worms. A writer from West Meriden, Conn., gives this satisfactory account of its use:

"On Tuesday, June 22d, we set three thousand plants, and on the next morning I took from one row of one hundred and eighty plants, two hundred and fourteen cut-worms, and on the same day, in the same field, I set twelve plants dipped in a solution of white hellebore, and to this time they remain untouched, while the plants in the rows on either side are more than half destroyed. June 24th *we set over two thousand plants treated in the same manner, and I find only one plant eaten, and that slightly.* The plants are not injuriously affected by the treatment. On plants already set, sift the powder from a muslin bag, and I am told they are protected perfectly. It appears to be a specific for the cut-worm. We use one-quarter of a pound to ten quarts of water" (*Count. Gent.*, for July 8, 1875, p. 425).

Coal Oil.—Not only is the odor of this substance serviceable in preventing attack, but the oil is also an insecticide. It could be mixed with dry sand and scattered around the plants to be protected, as for example, a tablespoonful about a cabbage or tomato plant. To check the depredations beneath the surface or to destroy the larva hiding there, it might be necessary to use it in a larger quantity. A teacupful of the oil (kerosene) to a pailful of sand has been recommended, to be renewed each week during the presence of the worms. A larger proportion of the oil might safely be used — a sufficient quantity to moisten the sand to a degree not preventing its running readily through the hand when distributing it.

Cultivation of sod-land.— It is claimed that where land is not allowed to lie in sod for over two years at a time, cut-worms will not accumulate in it, and consequently corn planted upon it when broken up suffers much less from attack.

Thick planting.— Planting more seed than is needed for maturity has frequently been found of service. When the larvæ are not numerous, two or three stalks of corn or beans may suffice them to complete their growth when near their pupation and the attack is late. Although the labor of subsequently thinning by hand is saved, the policy can not be recommended, as the relief obtained is but temporary, for the numerous progeny of the larvæ which you have helped to mature, may the following season require for their needs every stalk in a hill.

Late plowing.—A gentleman from Chautauqua county, N. Y., states, from the result of forty years experience, that plowing the ground late in the autumn or in the winter, if there is hard freezing afterward, will certainly destroy the cut-worms (*Count. Gent.*, for Feb. 29, 1874, p. 71).

The efficacy of such late plowing has been affirmed by many writers, and has also been presented in some of our entomological reports as one of the best of remedies. That it has not always been attended with success (see *C.-G.*, for March 5, 1874, p. 147, where the method is said to have failed entirely), may be accounted for by its not having been done at the proper time.

The plowing should be deferred until the cut-worms have become torpid, and it should be sufficiently thorough to crush the cells that they have shaped for their winter's sleep. These cells are believed to be essential to their survival of the winter. Within them, curled in a ring, and in such a position that the smallest possible portion of their surface (a single point only upon a few, not all, of their rounded segments) is in contact with the ground—they undergo freezing, perhaps alternate freezing and thawing over and over repeatedly, with impunity.

Under different conditions—with the soil enveloping them, resting upon and adhering to their entire surface, covering their breathing-pores and working within the joints of their abdomen—it would indeed be a marvel if the rigors of winter should not prove fatal to them. The entomologist knows how important it is that the cell shaped by the caterpillar for its pupation, in carefully prepared ground, for its three or four weeks occupancy in the summer, should not be destroyed if he would succeed in obtaining the moth for his cabinet.

Late plowing in the spring, just before a late planting, has also been recommended for infested sod-land, upon the theory that the cut-worms will have fed to maturity upon the sod, leaving the corn to spring up untouched, and with a more vigorous and healthful growth in the warmer soil and temperature of the advanced season.

Tin Bands.—A simple, cheap and permanent device for protection of single plants, is this: A strip of tin two inches wide, ten inches long, bent into the form of a cylinder, with a narrow lap at each end so as to hook together. The following is given in its favor:

"It works to a charm; no cut-worm ever goes over it; it can be hooked together and put over a plant, and remain there until the

plant is out of the way of the worm, then it can be unhooked and put away for another season. The inside should be painted, as the bright tin when new will concentrate the rays of the sun and burn the plant. They cost about $1.50 per 100, and will last a long time, if painted" (*Country Gentleman*, for May 31, 1877, p. 348, c. 1).

Paper Frames.— A writer gives this method for protecting from cut-worms in a garden or patch: "Prepare at leisure a quantity of small paper boxes — say from four to six inches square, without bottom or top, made to taper about half an inch. Place these around the plants, the widest part up, so that the worms can not crawl up their sides. Dipping the boxes in a strong solution of shellac will, with care, make them last for years."

Paper Wraps.— The bands and frames above mentioned can only give protection against those larvæ that feed above ground. A simple device, involving no expense and hardly any labor, often employed by gardeners to protect cabbage and tomato plants from the species that sever the stalks below the surface, is that of wrapping a piece of rather thick paper around the stalk as the plants are set in the ground. Allowing it to project a little distance above the ground may also circumvent the surface feeders. A burdock leaf, or some other leaf of sufficient size, is sometimes used instead of the paper.

Clover Traps.— Mr. T. Boynton, of Michigan, states that he has been very successful in entrapping cut-worms by placing wads of clover among his tomato plants. The worms would gather about them during the night, eat what they wanted, and secrete themselves in the earth close by, not over six feet distant. As many as eighty-two worms were found in the neighborhood of one of these balls of hay [made of about the size of an apple]; in another instance, seventy; in another, sixty-eight. On June fourth he claims to have destroyed over 15,000 of these worms, which were on and about his clover balls, by using boiling water. When the worms chance to be even slightly protected, nothing less than water boiling hot will kill them (*Country Gentlemen* for June 27, 1872, p. 409, c. 1).

An improvement upon this method has been recommended by Prof. Riley, the publication of which is made as these pages are to be handed to the printer (*Ann. Rept. Depart. Agricul.*, for 1884, pp. 299, 300). It is the poisoning of the bait to save the labor of collecting and killing the larvæ by the hot water, or otherwise.

Prof. Riley states: "We used chiefly clover sprinkled with Paris-green water and laid at intervals between the rows, in loosely-tied masses or balls, which served the double purpose of prolonging the freshness of the bait and of affording a lure for shelter." A modification of the method, employed by Dr. Oemler, of Savannah, Ga., was that of preparing cabbage or turnip leaves by dipping them in a well-stirred mixture of a tablespoonful of Paris green to a bucket of water, or sprinkling the side next the ground after first moistening with a mixture of one part of Paris green to twenty of flour, and placing them at distances of from fifteen to twenty feet throughout the field to be protected. Two applications of this character at intervals of three or four days, particularly in cloudy weather, were usually successful in ridding the field of the pest.

Trapping in holes.—An old method which is occasionally noticed as attended with good results, is that of making several holes a few inches deep about the hills, with a tapering stick to compress the earth at the sides, into which the worms would fall and be unable to crawl out. It is stated that in some instances where this has been resorted to, some of the holes were found to have been half-filled with cut-worms during a single night. They could be killed by reinserting the stick, or left to die, or to devour one another as some of the species are known to do when the opportunity offers in the absence of other food.

Digging out.—The recommendations of digging out and destroying the cut-worms when the plants are seen to be cut off by them, doubtless seems a poor remedy to those who have never tested it—as requiring too much valuable time and labor, and therefore, not available when large fields are to be protected. Its rejection or even its non-acceptance should not rest upon a mere prejudice against it, for if proven to be both practicable and effectual, it can not fail of being one of the best, if not *the best* of methods of dealing with this pest, for this simple reason: Many other methods merely prevent the feeding upon the protected crop, but leave the hungry creatures free, with appetites sharpened by delay, to attack and destroy other and often more valuable crops. With a cut-worm dug out from its retreat beside a wilted plant, and killed, there is this satisfaction, not only that its career for further harm is ended, but that it will not develop into a moth containing within its abdomen two hundred or more eggs, each of which would later produce a cut-worm.

Is the digging-out method practicable on a large scale, and will it give the results desired? An "Old Farmer" writes as follows of it, after premising that he had made a faithful trial of many remedies, but was now employing this in his corn-field, and that it was adopted, so far as he knew, by all good farmers.

"I have six acres of corn planted on sod which was turned over from a pasture just before planting. By the time it was up, the cut-worms made their appearance by hundreds, and my hired man was alarmed. 'All right,' said I, 'I am ready for them.' I set my two men at work on them, making regular days work of the business. Taking a row at a time, and digging down wherever a corn-plant was cut off, they went over the field in about half a day, killing over fifteen hundred. A few days later, they went over again, and did not get quite so many. I had the corn planted rather thick, and the plants which the worms took could be spared. At the third hunt, when the corn was about as large as the worms could manage I directed the crop to be regularly and evenly thinned, at the same operation. I have saved my corn, and have a handsome and even field. Had I let the worms have their way, I should certainly have lost half. I once lost over three-fourths. I have spent three days work in this way, worth $4—and I have saved by the operation at least one hundred bushels of corn on the six acres; more probably one hundred and fifty. *I think it pays!*" (*Country Gentleman* for June 14, 1877, p. 376.)

The letter states that the cut-worms destroyed, were "the plump brown grub that cuts the corn off just below the surface."

Another species of cut-worm differs in its habit of feeding from the above, in that it cuts the corn off just *above* the surface of the ground. It is this species which is referred to by Mr. Armstrong, secretary of the Elmira Farmers' Club, in his commendation of the digging-out remedy. He writes:

"There is really but one way to save the crop after the plants are once attacked by cut-worms — that is, to dig the worms out and kill them. It is not a difficult task, nor is it very costly. I presume that a fourth part of the loss sustained, would be a full equivalent of all the labor it would cost. The worm does the mischief at night, and before morning burrows in the ground near the spot where its depredations have been committed. A practiced eye will readily discern the entrance to the hiding-place into which the

worm has passed and lies concealed. The way to bring the pest up is to thrust a pointed knife down near the hole and lift out the earth to the depth of two or three inches, when the malefactor will lie exposed to view, and can be instantly destroyed. I have known large fields to be cleared by this process at a cost of labor so slight as to bear no comparison with the loss that would have otherwise resulted" (*Country Gentleman* for Jan. 6, 1881, p. 8).

The idea has been advanced that dandelions (*Taraxacum dens-leonis*) foster the cut-worm, and if these were carefully cut up whenever seen, its injuries would be greatly mitigated (*Country Gentleman*, June 20, 1872, p. 392, c. 2). Examinations about the plants during the month of June, would show if there is reason for this belief.

Starvation. — An instance is related where cut-worm attack was forestalled by removing their food-material from the ground. A piece of sod was turned over before the grass had made much growth. It was dragged, to bring up the roots and dry them. A week later, another dragging was given it, which destroyed every green thing. It was then planted with corn, and entirely escaped the usual cut-worm attack (*Country Gentleman*, May 6, 1875, p. 277, c. 1).

This method can not fail of being as effectual against cut-worms as for destroying the white grub, for which, in a former paper, I have strongly recommended it.

TWO PREVENTIVES SPECIALLY COMMENDED.

It will be observed that quite a number of preventives and remedies have been given above, and it may be asked why this is so frequently done in our entomological writings. We reply: A method adapted to the soil of one locality may not be as effectual in another; it may be more difficult of application in one place than in another; it may be available for garden use, but not for the more extended area of field and farm; it may require to be thoroughly tested before its real merit is known and it can be urged to the exclusion of others.

It would seem, however, that we have in the above, two preventives for cut-worm attack in corn fields, either of which may be relied upon for general use. We speak thus strongly in their favor, in consideration of the tests made of their efficacy, as in the statements subjoined. Of the protection by salt, Mr. J. L. du Fief, of Montgomery county, Maryland, writes as follows:

"I tried the salt by selecting a piece of ground occupied for three years by a straw-rick, and upon which my cattle ran. After removing the old straw and manure and top-dressing the adjoining field, I selected this spot, as I had always found worms worse in such places. Immediately after planting the corn, I applied one table-spoonful of salt scattered over the hill. *Not a hill was touched by cut-worms, but all around this plot, where salt was not applied the worms cut two to three out of five hills,* and we often found one to fifteen cut-worms in a hill, but none where salt was applied."

Mr. du Fief also bears testimony to the value of the copperas preventive. He gives his manner of preparing the seed-corn, which differs slightly from that stated above mainly in time of soaking.

"I pulverized two pounds of copperas at night, and the next morning put in soak, and I put one and a half bushels of corn in soak in a separate vessel at night. After soaking twelve hours, I poured off the water from the corn into a tub; I then added as much water as will cover the corn, and add to it the copperas water, and thoroughly mix and pour over the corn, and let it remain in copperas water twelve hours; I then poured off the copperas water and rolled the seed-corn in J. J. T——'s Excelsior, or plaster."

Condensing his details — a forty-four acre field was planted in corn — first ten acres without the copperas preparation — next to it nearly ten acres with the prepared seed, and the remainder with unprepared — all treated alike, except the copperas application. He writes:

"To the surprise and satisfaction of myself and hands it [the prepared corn] came up regular, green and vigorous, and grew rapidly. I soon found it necessary to replant. I found, on examination, *not a hill cut or a worm to be found where the copperas was used,* and the entire field elsewhere cut from two or three hills out of five, with, sometimes, fifteen cut-worms in a hill."

The results, as obtained by his neighbors, as well as by himself, were pronounced most marked and astonishing (*Country Gentleman,* for April 23, 1874, p, 259, c. 3).

Mr. E. Harvey, of Chester county, Pennsylvania, confirms the efficacy of the salt application, as above directed (not applied to the blades of corn, which it will kill), based upon the results of a great many trials made by a great many different persons during the last fifteen or more years (*Country Gentleman,* for July 2, 1874, p. 419, c. 4).

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